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MODERN METHODS OF COALING VESSELS.

Every marine engineer knows the exasperation which is caused by the usual methods of bunkering coal. This work not only consumes much of the time while a vessel is in port but it is costly and dirty as well. In order to obviate such troubles attempts have been made in the direction of constructing mechanical coaling barges of more or less efficient types, and the attention which has been paid to this branch of industry has gradually led to the perfecting of appliances for rapid, clean and economical bunkering with the additional advantage that in many of these equipments automatic weighing machines are included so that an accurate register is kept of the amount of coal delivered to a vessel, thus in many cases saving a considerable amount of dispute.

Another difficulty which has been experienced in connection with the older methods has been that it appeared almost impossible to transfer coal to the bunkers of a vessel without breaking it up from the large sizes, which are so desirable, into small coal, which is not nearly so efficient from a firing point of view. Any appliance which obviates this breaking up deserves the most careful consideration, and it is our intention to describe some of the equipments which have been constructed by the firm of A. F. Smulders, of Schiedam, near

FIG. 1.—EARLY TYPE OF SELF-PROPELLED COALING BARGE WITH LADDER SUSPENDED BY CABLES.

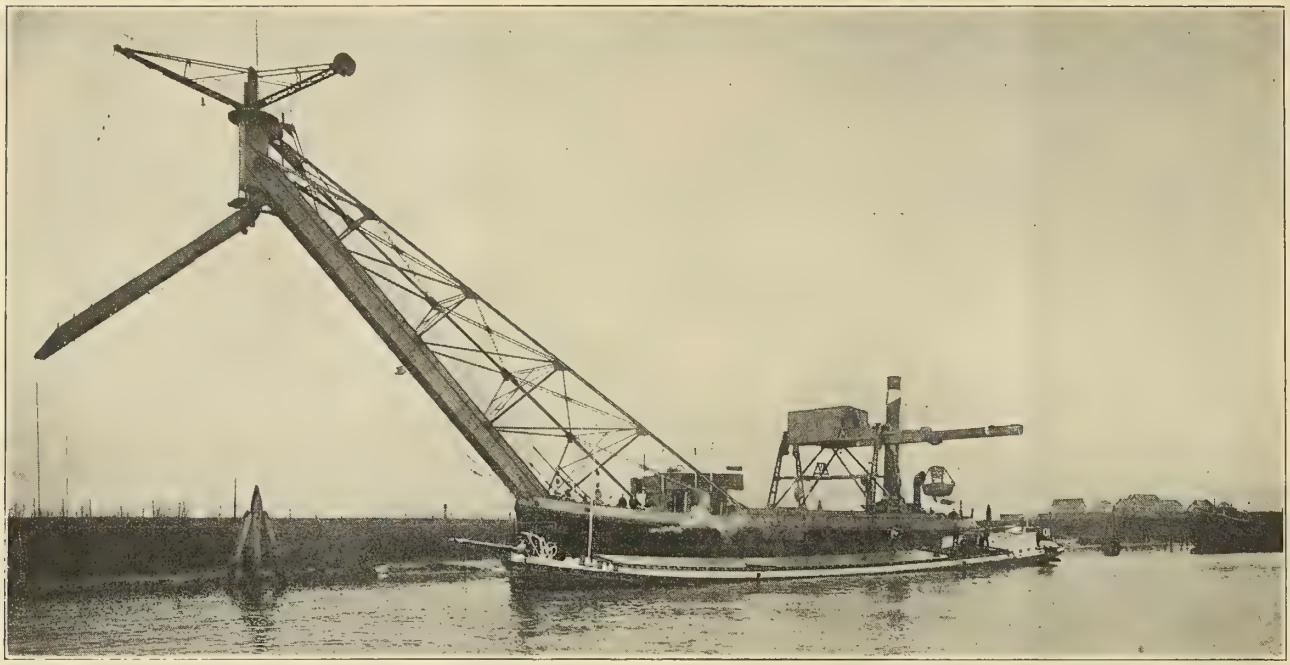


FIG. 2.—MODERN TYPE OF SELF-PROPELLED COALING BARGE WITH LADDER AND RECEIVER FIXED.

Rotterdam, for the economical handling of coal into bunkers. Before giving such description, it may be well to preface the matter by saying that one of the important points which will be noted is the entire enclosure of the coal-carrying chutes, so that the evil of depositing coal dust over the vessel, which involves so much cleaning after the boat has left port, is done away with to great advantage.

The first step in the question of bunkering a vessel is that of conveying the coal from the nearest adjacent delivery head to the vessel itself, and this is not unfrequently a very serious problem. The more important ports are, of course, now usually equipped with coal staithes, or other coal-handling appliances, whereby the fuel can be transferred directly into the hold of the vessel lying alongside at the wharf; but in smaller ports these appliances, which are costly to construct, and in some cases costly to maintain, are absent. In addition to this, however, is the fact that it is often a matter involving considerable delay if a vessel has to wait its turn at such a coaling point, as accommodation must necessarily be limited, and other things being equal it is far preferable to have some device whereby the vessel at anchor in the roadway or in its normal position for discharging or receiving cargo can be simultaneously coaled. For this reason self-propelling coaling vessels of the type illustrated in Fig. 1, showing the process of bunkering a 17,000-ton ocean-going steamer, have become of great importance, inasmuch as they can obtain their cargo of coal at any convenient point adjacent to a railway line where a small craft can anchor and then proceed under their own steam to the larger vessel which requires bunkering, and which may be occupying more important wharfing space, and there can discharge their cargo into the bunkers of the ocean-going vessel. The bunker space of the steamer permitting, 250 tons of coal per hour can be conveyed from one of these vessels with a total crew of only seven men. Moreover, to load or discharge cargo is well nigh impossible when an army of coal heavers are continually streaming up and down both sides of the steamer, so that the advantage of the new system in saving time is apparent.

FIG. 3.—COALING STARBOARD BUNKERS FROM PORT SIDE OF VESSEL.

These self-propelled coaling vessels have a hold which is divided into compartments by means of transverse bulkheads, and there is, theoretically, no limit to the size and number of these compartments. Hence the total hold capacity of the vessels depends entirely on the requirements of the port or harbor in which they are to serve. There is no reason why the hold capacity of such a vessel should not be as much as 2,500 tons or even more, and one such vessel has been constructed having a capacity of about 1,100 metric tons. The vessel shown in the illustration has a hold capacity of from 600 to 700 metric tons and a rate of discharge of 250 tons per hour. By means of sliding doors the compartments formed by the transverse bulkhead empty themselves one after another into the buckets which run in a tunnel along the ship's keel. This endless conveyor or bucket chain is driven by either of the two engines which propel the twin screws of the vessel.

Before reaching the upward bend which enables the bucket chain to pass on to the ladder shown in the illustration after the fashion of an elevator, the conveyor runs over an automatic weighing machine, which can weigh accurately within 1 percent, even if the vessel lies with a list of 10 degrees either fore, aft or athwartship. By means of the self-registering arrangement the weight of the coal delivered can be read off at any moment.

Two points with regard to this system of coal conveying may be noticed. The first is that the motion is exceedingly smooth and gentle, so that the coal during the process of manipulation does not suffer in the least, and is therefore not broken up into smaller pieces. Moreover, the shape of the buckets of the conveyor, which has the appearance of a vertebrate belt, has been so designed as to prevent the spilling of coal during its transfer from the coaling vessel to the steamer.

is even possible to fill the starboard bunkers if the coaling vessel is moored at the portside of the steamer (Fig. 3). An examination of Figs. 2 and 3 will also show an improvement in the method of handling this chute. In the earlier form the telescopic chute was manipulated by means of a derrick, while the more modern practice is to raise, lower or move the chute to right or left by means of a pivoting crane fitted at the top of the receiver. These self-propelled coaling vessels have twin screws, enabling them to proceed at a fair speed actuated by two engines fed by a Scotch boiler. The coaling vessels are lighted by electricity, so that bunkering may be proceeded with at night.

Fig. 4 shows one of these coal-carrying bunkering vessels engaged in bunkering a steamer while the latter is being repaired in drydock, and is illustrative of the saving of time by these modern means.

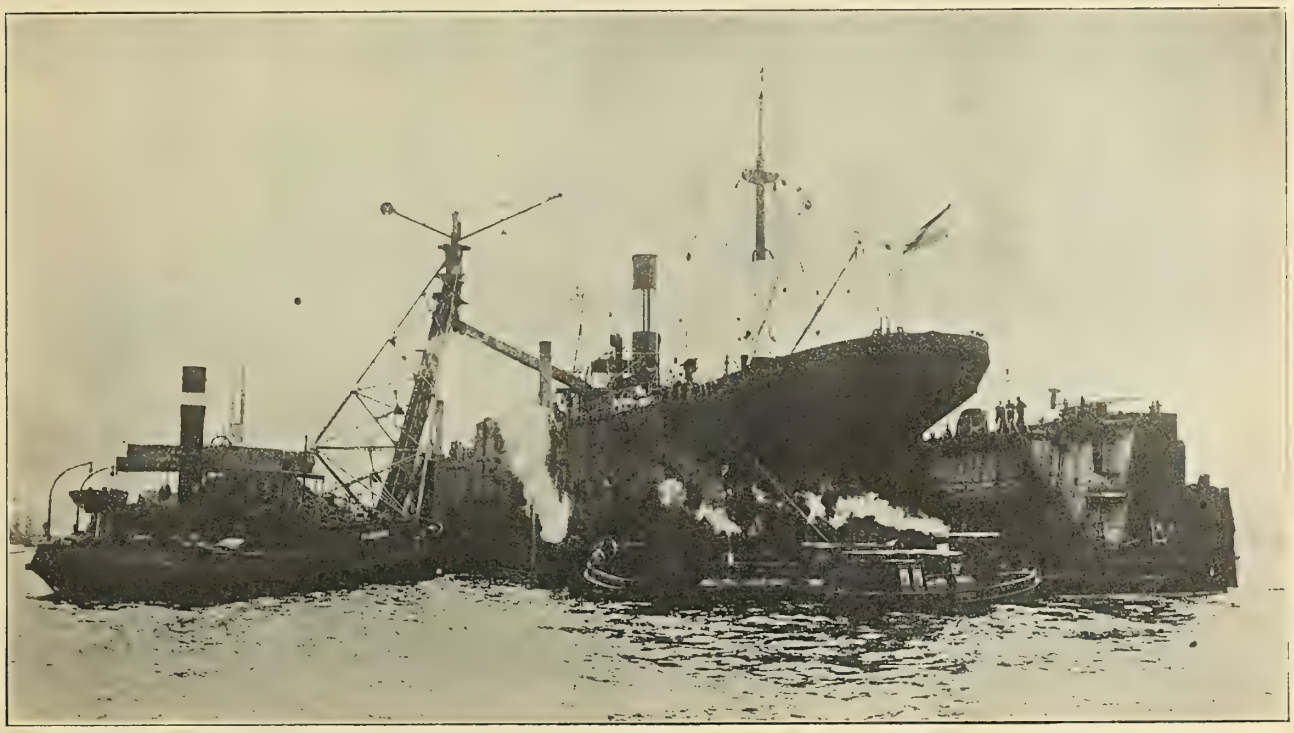


FIG. 4.—COALING A VESSEL WHILE IN DRY-DOCK BY MEANS OF SELF-PROPELLED COALING BARGE.

Turning now to the elevator portion of the vessel the ladder which is fixed at the stem performs the office of a conveyor in its ascending motion to the receiver. In the earlier types of coaling vessels of this description the ladder was made movable, being suspended by cables, as shown in Fig. 1, so that it could be raised or lowered according to the height of the bunkers to be filled. When the buckets reached the top of the ladder they bent over and emptied the coal into the receiver, from which the coal traveled through the chute shown in the illustration into the steamer's bunkers without being exposed to the open air. As the ladder was movable the receiver in its turn had to be made movable also; it was therefore suspended in a position abutting on the top of the ladder by means of a shaft on which it was pivoted.

In subsequent designs the ladder and receiver were made fixed, as shown in Fig. 2. A telescopic chute, through which the coal reaches the bunkers of the steamer, is attached to the receiver by means of a universal joint, so that when the coaling barge is moored alongside the various bunkers of a ship can be reached with a minimum amount of manipulation. It is evident that bunkering may be effected by this means at a considerable distance between the coaling vessel and the steamer by the simple means of lengthening the chute, and it

When the hold of the coaling vessel is filled with coal, she moors alongside the steamer which is to be supplied, or if lighters happen to lie alongside for purposes of loading or discharging cargo she moors alongside the lighters. A fore steam winch sets the crane on the receiver in motion, and the telescopic discharge chute is forthwith given the desired direction and inclination as well as the requisite length, causing the chute to reach immediately above or into the bunkering hatch. The captain of the coaling vessel having been warned by a signal that all is ready, telegraphs the engineer to start the engines, and this having been done he orders the tunnelman in the same way to admit coal to the conveyor. By means of a very simple system of leverage the tunnelman opens one of the sliding doors in the sides of the tunnel and allows the coal to glide on to the conveyor. The floor of the tunnel on which the tunnelman moves about is made of planks, placed a little apart, so that he is able by the light of the incandescent lamps to watch the conveyor moving underneath, and by opening the doors to a greater or less extent he is able absolutely to control the supply of coal to the conveyor. A clinometer in the tunnel enables the man to ascertain whether the vessel preserves an even keel athwartships.

The sliding doors mentioned above are of sufficient size for

the largest lumps of coal to pass through, while the levers which open these doors are so arranged that a single pressure downward will immediately close a sliding door. This is often necessary to prevent the conveyor from being overloaded by a rush of fine coal following the admission of a big lump.

The loaded conveyor, before reaching the ladder, passes over a weighing machine which adds automatically and with great accuracy the quantity of coal being carried over it, and from it the quantity of coal delivered to the steamer alongside may at any moment be read off.

Whenever a bunker has been filled up and it becomes necessary for the discharge chute to be shifted to another hatch the supply of coal to the conveyor is stopped and also the engine driving the conveyor. It is remarkable to see during the process of bunkering how easily the coaling vessel and her apparatus are handled. While actually bunkering only, the fireman who regulates the supply of steam, the engineer watching his engine and the tunnelman are at work, and the vessel can in this way discharge 250 tons of coal an hour until her hold is quite empty, the sloping side of the hold causing the coal to glide down of its own weight, and no trimming is required.

Up to now we have dealt with the problem in its simplest form, namely, given a coaling vessel of a definite capacity how to transfer its contents to a steamer with a minimum amount of time, trouble and deterioration of fuel. It is evident, however, that with the arrangement described above some loss of time must occur in transit of the coal vessel to and from the steamer when its contents are exhausted. Should the problems of rapid coaling demand that in the case of larger vessels additional facilities be given in order to make the coaling process as nearly as possible continuous, the provision of duplicate self-propelled vessels would be an expensive matter, and in order to deal with this proposition the firm above mentioned has developed an auxiliary piece of apparatus on its later vessels which has the effect of increasing their capacity. This apparatus is a traveling coal transporter, and Fig. 2 shows a coaling vessel having a capacity of 1,000 tons of coal, and also provided with a traveling coal transporter of the grab type, by which the vessel is able while actually engaged in bunkering a steamer to assist in replenishing the coal in its own hold.

The apparatus consists of an electric transporter mounted on four supports which run along the entire length of the hatch coamings, and take the coal from the lighters alongside. The telescopic portions of the gear, which may be seen in the illustration, can be extended either to port side or starboard in this way, and form a track for the grab or bucket running to a certain distance over the vessel's side. This grab has a capacity of 70 cubic feet, and can easily handle 50 tons of coal per hour. This is not, of course, a maximum figure, for such a process as installations for the same end of a very much larger capacity can be built. It will be seen that the operation of this grab does not interfere with the simultaneous replenishment of the cargo by other means, and which has the advantage that, owing to the telescopic arrangement, the transporter can be contracted when the apparatus is at rest so completely that it presents no obstacle to the proper navigation of the vessel.

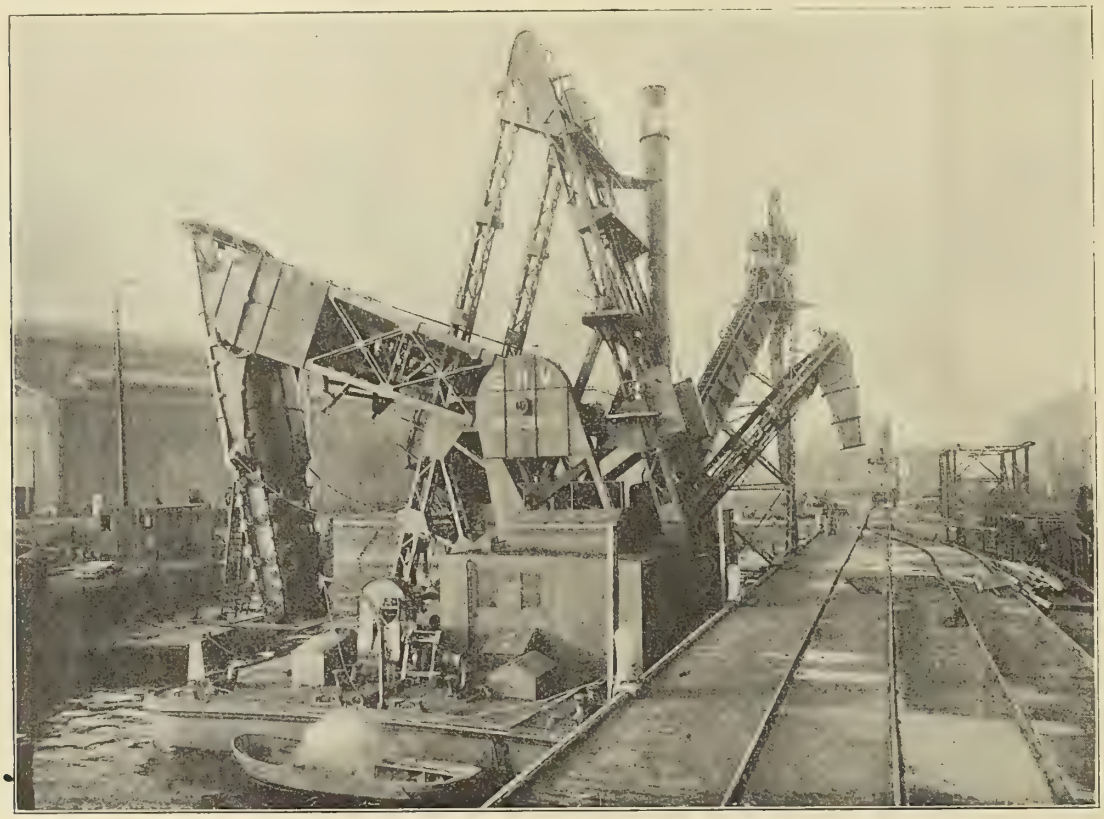


FIG. 5.—APPARATUS FOR TRANSFERRING COAL FROM BARGES TO VESSEL OR TO RAILWAY CARS ON SHORE. HOURLY CAPACITY 500 TONS.

We may now deal with one of the latest types of apparatus used in coaling a vessel which has been constructed up to an hourly output of 500 tons of coal. This is illustrated in Fig. 5, and its use is to take coal out of the hold of barges moored alongside and to discharge it into the bunkers of the steamers, the hold of coaling or other vessels, or to deposit it on to railway trucks or on the shore. It is really a combination of a bucket elevator and a coaling vessel. As, however, it does not have to carry coal but simply to take it out of barges moored alongside and discharge into a ship or on shore, it has no hold, being erected on a very strong pontoon which easily bears the heavy weight of the structure. Although it can be built self-propelling this type of apparatus has not up to the present been

made self-portable. The coal is taken out of the barges by means of a hydraulically-operated swinging ladder, seen to the left of the illustration, suspended to the end of a movable bearing arm and fitted with a double row of buckets. This bearing arm is lowered until the buckets which have been set in motion reach the coal in the barge's hold and fill themselves. The buckets then go up on the pontoon side of the swinging ladder. When they reach the bearing arm, which during the operation of digging hangs in a nearly horizontal position, their position changes from vertical to a horizontal one, so that they empty their contents into a channel which has nearly the same cross-section as the buckets. In this channel the coal is pushed forward by the buckets, which move along the bearing arm until it reaches the end and passes into a fixed receiver, while the empty buckets return to the swinging ladder along the upper side of the bearing arm.

When the coal is in the receiver it has two alternative paths. If it is to be discharged into the hold of coaling or other vessels, into trucks on shore, it passes from the fixed receiver on an endless conveyor supported by a movable bearing arm (shown projecting over the line of rails on the quay), which during the work is kept in a nearly horizontal position. If, however, it is required to discharge directly into the bunkers of steamers the coal passes to a ladder and telescopic chute at the stern of the pontoon, provided with self-registering weighing machines in the same way as in the self-propelled coal vessels described above. When the apparatus is at rest or in tow the first three charge and discharge chutes can be hoisted until they do not overhang the pontoon in any direction. This allows the elevator to be taken in tow without interfering with navigation in crowded harbors.

As the swinging ladder has occasionally to operate at a considerable distance outside the pontoon, and therefore the latter would list to such an extent that the accurate working of the weighing apparatus might be interfered with, an arrangement is provided which causes water to be automatically pumped into tanks fitted opposite to the swinging ladder as soon as the list exceeds a low limit, thus maintaining the equilibrium of the whole structure. Moreover, the hull of the elevator is divided into a large number of watertight compartments, so that if a collision were to take place the danger of sinking would be reduced to a minimum.

The above description, which is illustrative of the work of one firm in this specialized direction, is valuable as indicating the line along which the problems of coal bunkering can be best attacked and overcome. A very large proportion of success in this sphere of industry is only obtained by the actual encountering of practical difficulties and the overcoming of these obstacles by attention to detail in construction, so that an account of actual plant manufactured and in use is of far more value than a good deal of theory on the matter. For this reason it is hoped that the above notes may be of interest to all engineers interested in the problems concerning the efficient handling of coal.

Speed Trials of H. M. S. Gloucester.

H. M. S. *Gloucester* is a second-class protected cruiser, 450 feet long, 4,800 tons displacement, built at the naval construction works of William Beardmore & Company, at Dalmuir, Clyde. She is fitted with Parsons turbines on four shafts, and her boilers are of the Yarrow watertube type, adaptable for both coal and oil fuel. The boilers were also constructed by Beardmore & Company. Her armament consists of one 6-inch gun forward on the forecastle and one aft on the upper deck, with ten 4-inch guns for broadside work.

The official trials were for speed, gun practice, torpedo practice and maneuvering. They were effected on the Firth of Clyde.

The first speed trial was for twelve consecutive hours progressively. This trial was subdivided into three periods of four hours each for 1,600, 4,400 and 8,800 shaft-horsepower each. The speeds attained at these powers were 12.837, 17.549 and 20.799 knots, respectively. A second trial was of a thirty-hour run. It was divided into two periods—one of eight hours at 18,000 and one of twenty-hours at 13,500 shaft-horsepower. The result in speed was 25.084 and 23.447 knots, respectively. Later, after the gun and torpedo trials, there was a full-power run of eight hours. On this the mean speed attained was 26.3 knots, or 1.3 knots in excess of the estimate of 25 knots. The contract indicated horsepower was 22,000 and the actual was 24,150. These results were necessarily regarded as satisfactory. The maneuvering trials were equally satisfactory. After they were completed the ship was taken back to Dalmuir, where in the large fitting-out basin she was opened out for close inspection before being commissioned.

NEW BRITISH BATTLESHIP CONQUEROR.

The British battleship *Conqueror,* which is being built on the Clyde at the Dalmuir Naval Construction Works of Messrs. Beardmore of Glasgow, is expected to be ready for launching early in 1911. She is a sister ship of the *Monarch* and *Thunderer,* which are being constructed at the shipbuilding yards of Messrs. Armstrong, Whitworth & Company, Newcastle-on-Tyne, and the Thames Ironworks Company of London, respectively. The keel of the *Conqueror* was laid in March, 1910, and her construction has progressed in a very satisfactory manner, but she would have been launched two months earlier if the recent lockout of the shipyard ironworkers had not taken place.

She is some 55 feet longer than the *Dreadnought;* that is to say, her length between perpendiculars is 545 feet, as compared with the *Dreadnought's* length of 490 feet between perpendiculars.

The following particulars and principal dimensions of the two boats will give some idea of the rapid progress which has been made in battleship design in the short time that has elapsed since the *Dreadnought* was built:

	Dreadnought.	*Conqueror.*
Length, B. P.	490′ 0″	545′ 0″
Breadth	82′ 0″	88′ 6″
Draft	25′ 6″	27′ 6″
Displacement in tons	18,000	22,500
Shaft horsepower	23,000	27,000
Speed at sea	21 knots	21 knots
Main battery	Ten 12″ guns	Ten 13.5″ guns
Secondary battery	Sixteen 4″ guns	Sixteen 4.7″ guns
Cost	£1,250,000 / $6,080,000	£1,750,000 / $8,520,000

Official verification of these dimensions of length and beam, etc., is unobtainable on account of the British Admiralty having followed out that system of secrecy which is employed by the Admiralties of other nations. But as our information is from a reliable source, the particulars may be accepted as sufficiently accurate.

The outward appearance of the *Conqueror* will greatly resemble that of the *Dreadnought,* with two smoke stacks and one tripod mast. The mast will carry the fire control station, also the receiving wires in connection with the wireless telegraph system, and it will be placed about midships. With this tripod arrangement there will be no wire-stay ropes to the mast, so that a clear deck for action will be obtained. Like the *Dreadnought,* the *Conqueror* is of the one-caliber, all-big-gun type.

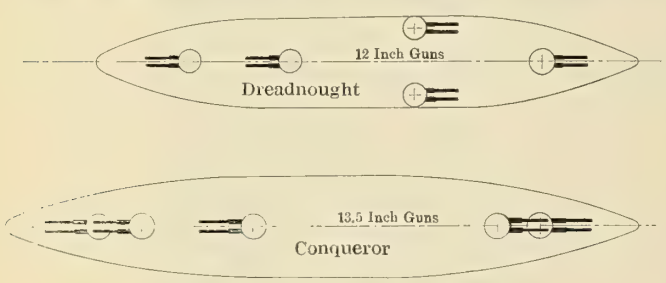
Many improvements have been made in the internal arrangements of the battleship, and one of the most notable of these is the placing of the officers' rooms in the forward part of the ship, while the crew's quarters are situated at

the stern. The old system of fitting sheep pens and hen runs on the weather deck has been abandoned, and the more modern cold storage room will be provided and fitted with the necessary refrigerating machinery to enable the ship to carry frozen meats. The ship will have stockless anchors, each weighing about 8 tons, and they will be stowed in the hawse pipes.

The machinery installation of the *Conqueror* will consist of steam turbines and watertube boilers, together with the usual auxiliary machinery, electric lighting machinery, steam heating and evaporating plants, deck machinery and steam capstans for maneuvering.

The turbine machinery is of the Parsons type and consists of ten turbine units on four shafts. On each outboard shaft there will be one high-pressure ahead turbine, and one astern turbine, and on the port inboard shaft there will be one low-pressure ahead and astern turbine, and one high-pressure cruising turbine, while on the inboard starboard shaft there will be one intermediate-pressure cruising turbine and one low-pressure ahead and astern turbine. As is usual in the latest four-shaft turbine arrangement, all of the turbines are designed to turn outboard when driving the ship ahead. The shaft horsepower will be 27,000, and the speed of the ship at sea will be 21 knots.

The engine room has a central fore-and-aft bulkhead, dividing the engine power into two completely independent sections, each with complete sets of auxiliary machinery consisting of condensers, air pumps, centrifugal circulating pumps, evaporators, distillers, fire and bilge pumps, etc.



COMPARISON OF DREADNOUGHT AND CONQUEROR.

The eighteen watertube boilers will be arranged in three independent watertight compartments, and the uptakes from all the boilers will be connected up to two large oval funnels. The steam pressure at the boilers will be about 200 pounds, and 175 pounds at the throttle valve of the high-pressure turbines. The boilers are designed for coal or oil fuel, and the fuel capacity will give the vessel an exceptionally wide range of action. The coal capacity is 2,700 tons, and the oil fuel 1,000 tons.

The *Conqueror* is provided with five barbettes, and each barbette will be fitted with two 13.5-inch guns. All the barbettes are on the center line of the ship. This arrangement of guns is a departure from that adopted on the *Dreadnought*, but is somewhat similar to the latest American practice. Our sketch shows the approximate positions of the guns in both ships. In the American designs the middle barbette is usually placed at such a height that the guns in it can be fired over the guns in the two after barbettes, and the inner of the barbettes forward and aft are at a higher level than the outer barbettes. But in the *Conqueror* the middle barbette is, like the two forward of it, on the forecastle deck. The two after barbettes are on the upper deck. In the *Dreadnought* there are five barbettes, each having two 12-inch guns. The forward barbette is placed on the forecastle deck and the others are all on the upper deck. With this arrangement, only eight guns can be fired on either broadside on the *Dreadnought*, but on the *Conqueror* all of the ten guns will be available for use on either broadside, and four will be able to fire straight ahead or straight astern, the second and fourth barbettes being higher than the first and fifth. This disposition of guns seems to be a better one than the American, for the greater astern fire of the American ship does not fully compensate for the placing of the weight of the two central guns so high up.

The secondary armament of the *Conqueror* will consist of sixteen 4.7-inch quick-firing guns, but the positions of these guns can at present only be conjectured.

The armor protection is the element of a battleship's design of which, perhaps, least is known. This is chiefly because the extent and the thickness of the belt is not perceptible to the eye. However, it is accepted that in the *Conqueror* and her sister ships the belt armor is about 400 feet long amidships, and that the protective deck, which is 1 inch in thickness inside this armor, is 3 inches thick at the extremities forward and aft. Where the belt ends, armored bulkheads are fitted to complete the citadel. On the ship's sides the armor extends upwards for 20 feet from about 4 feet below the waterline, and the thicknesses range from 8 inches for the highest strake to 12 inches for the lowest. There is nothing unusual in this thickness, and the disposition is similar to the latest warship practice.

To protect the ship from torpedo attack below water, she will be fitted with the latest type of torpedo defense nets all fore and aft. These metallic nets will extend from about 3 feet above the waterline to well below the vessel's keel. When not in use the nets will be stowed on the ship's deck all along the sides.

The ship has twin rudders of the battle-axe type. They are hung from the stern structure and are unsupported outside of the hull. This double-rudder system will give the ship a greater turning power than could be obtained with the usual single rudder. On each of the four propeller shafts there is one three-bladed solid bronze propeller. The two outer propellers are situated some distance forward of the inner ones. To reduce the rolling of the ship at sea, very deep bilge keels are provided.

Steel Tug Auburn.

The Staten Island Shipbuilding Company, Port Richmond, N. Y., has recently completed the steel tugboat *Auburn* for the Lehigh Valley Railroad Company. The vessel is 108 feet long, 36½ feet beam, and 14 feet draft. Her deck, deck-house and pilot-house are of steel.

The vessel is propelled by a fore-and-aft compound engine, with cylinders 20 to 42 inches in diameter by 28 inches stroke of piston, and develops 900 indicated horsepower. One steel boiler (the largest in any New York tug with the exception of the *Mary F. Scully*), 16½ feet in diameter, and containing four Morison corrugated furnaces, built by the Continental Iron Works, of Brooklyn, N. Y., furnishes steam at 150 pounds pressure. The boiler is covered with Keasby's magnesia sectional covering. The auxiliary machinery includes a fire pump that will throw 1,000 gallons per minute. A Bates steam steerer makes easy work for the captain, and a Yale & Towne differential chain pulley block in the engine-room enables the engineer to remove the cylinder heads quickly and without much effort on his part. There is a Kahnweiler metallic lifeboat, and in the pilot-house is a "Rescue" patent fire extinguisher, furnished by the S. F. Hayward Company, of 39 Park Place, New York. This craft has 150 electric lights, which are fed by a continuous-current electric generator, furnished by the General Electric Company, of Schenectady, N. Y., and she is the 530th vessel built by the Staten Island Shipbuilding Company. She represents an outlay of about $75,000 (£15,400).—*Marine Journal.*

TORPEDO BOAT DESTROYERS PERKINS AND SERRETT.

The *Perkins* and *Sterrett* are two of the ten torpedo boat destroyers, authorized by an act of Congress, May, 1908, which have recently completed their official contract trials. The contract for these vessels was awarded to the Fore River Shipbuilding Company, of Quincy, Mass., in October, 1908. The contract time was, respectively, twenty-three and twenty-four months, and the price for each was $610,000 (£125,400), which is exclusive of equipment and certain other articles furnished by the government.

The principal hull dimensions and other data are given below:

Material	Mild steel.
Length between perpendiculars	289 ft. 0 ins
Length over all	293 ft. 10½ ins.
Beam extreme over guards	27 ft. 0 ins.
Beam on L. W. L.	26 ft. 0½ ins.
Mean draft	8 ft. 4 ins.
Displacement	743.5 tons.
Block coefficient of fineness	.414
Capacity of oil fuel tanks	242 tons.
Capacity of reserve feed tanks	14.6 tons.
Total horsepower	12,000
Speed	29½ knots.

Armament: Five 3-inch, 50-caliber semi-automatic guns; three 5-meter by 45-centimeter deck torpedo tubes; three 3-inch guns, all of which are furnished by the government.

PROPELLING MACHINERY.

The propelling machinery consists of two 72-inch, 14-stage Curtis marine turbines, operating two shafts, each with one propeller. The backing turbines are contained within the same casings as the ahead turbines and form the after part of each turbine. The main exhaust nozzle is located on each turbine casing, in such a manner as to conduct the exhaust steam from both backing and ahead turbines to the condenser placed on the outboard side of each turbine. When going ahead the turbines turn outboard, the starboard propeller being right-hand and the port propeller left-hand. The turbines, together with all the engine-room auxiliaries, are placed in one compartment aft of the boilers. The turbine-operating valves are placed on the forward engine-room bulkhead, and consist of throttle valves connecting respectively the ahead and backing steam chests by lines of steam piping to the main steam lines situated on each side of the ship.

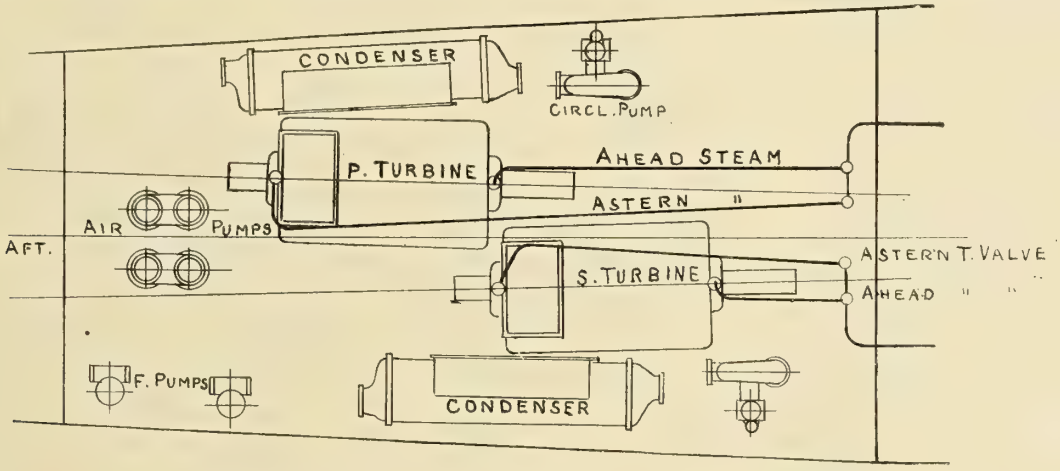
There are two main twin, single-acting air pumps placed aft, one on each side and near the center line of the ship. Two simplex double-acting feed pumps are also located aft in the engine room on starboard side.

The condensers are box-shaped, with semi-cylindrical top and bottom. The tubes are ⅝ inch diameter by 14 feet 2 inches long, and are fitted in the tube sheets with packed glands. The combined cooling surface of the two condensers is 9,546 square feet. The cooling water enters at the bottom and leaves at the top of the condenser. There are installed neither dry vacuum pumps nor augmenters. Two independent engine-driven circulating pumps are placed, one on each side of the ship, immediately forward of each condenser. There are also placed in the engine room two evaporators and one distiller, a feed heater, two 6-kilowatt turbine-driven dynamo sets, two lubricating oil pumps with oil cooler and oil cooler circulating pump, fire and bilge pumps, feed tank and an auxiliary condenser.

BOILERS.

There are four Yarrow express type watertube boilers, placed in two watertight compartments, with one fire-room between each two boilers. The boilers are made for burning oil only, and contain each one furnace without grate. They are designed for a working pressure of 265 pounds, and have no superheaters. The tube-heating surface is 4,500 square feet in each boiler, the two inner tube rows (near the furnace) being 1¼ inches diameter, while all others are 1 inch diameter.

The oil-fuel tanks are located forward of the forward boiler room, and the oil-settling tanks abreast of the boilers. The oil burners are of the Koerting patent type, and consist of seven oil sprayers, the oil being sprayed by mechanical atomization without the use of either steam or compressed air. The air required for combustion is supplied to each boiler room by two turbine-driven forced draft blowers. The oil-burning arrangement, with respect to pumps and heaters, is in its essential details similar to that described in a general way in an article—"Modern Torpedo Boat Destroyers"—which appeared in the August number (1910) of INTERNATIONAL MARINE ENGINEERING.



GENERAL ARRANGEMENT OF ENGINE ROOM ON DESTROYERS PERKINS AND STERRETT.

There are three smoke pipes, of which the middle pipe serves the two middle boilers, and is fitted with a division plate.

Besides the fuel-oil supply and service pumps in the fire-room an auxiliary boiler feed pump is installed in each fire-room.

PROPELLERS AND SHAFTING.

The propellers are cast solid, and are made of Monel metal. They have each three blades, machined to give a true pitch of 6 feet 3½ inches, with a diameter of 6 feet 6¾ inches, the projected area of the three blades being 18.21 square feet.

The line shafting is made of Class A steel forgings, 8¼ inches diameter with 4-inch hole. The rotor shafts are made hollow in one piece.

TRIAL DATA.

The standardization trials of both of these destroyers were

made on a course off Rockland, Me., for the *Perkins* on Sept. 27, and for the *Sterrett* Nov. 1, 1910. The official speed trials of the *Sterrett* were undertaken on Nov. 2, 3 and 6, over a course off the New England coast, and the data appended below are for this ship only.

4-hour full-speed trial:	
Average pressure at boilers, gage	263 pounds.
Average pressure at engine room, gage	250 "
Average pressure at auxiliary exhaust, gage	13.6 "
Nozzles open, each turbine	14
Average pressure at turbine steam chest, gage	228.5 "
Average pressure at first ahead stage of turbine, gage	87 "
Average vacuum	27.25 ins.
Average pressure in fire room, inches of water	3.28
Average revolutions per minute, forced-draft blowers	1,537
Average pressure in lubricating-oil system	15 pounds.
Average double strokes, main air pumps	33
Average revolutions per minute, circulating pumps	180
Average temperature injection, degrees F	50
Average temperature discharge, degrees F	89
Total shaft horsepower	12,789
Pounds of water per hour per horsepower, all purposes	14.85
Nautical miles run per ton of fuel oil	3.733
Pounds of fuel oil per shaft horsepower per hour	1.425
Pounds of water evaporated per pound of fuel oil per hour	10.427
Draft, mean, on trial	8 ft. 5 9/16 ins.
Corresponding displacement	754 tons.
Speed per hour	30.368 knots.
Average revolutions per minute of turbines	631
Slip of propellers	22.6 percent.
12-hour, 25-knot speed trial:	
Average pressure at boilers, gage	263 pounds.
Average pressure at engine room, gage	252 "
Average pressure at auxiliary exhaust, gage	5.2 "
Nozzles open in each turbine	7
Average pressure at turbine steam chest, gage	243 "
Average pressure at first ahead stage of turbine, gage	40.5 "
Average vacuum	28.76 inches.
Average pressure in fire room, inches water	1.82
Average revolutions per minute, forced-draft blowers	1,514
Average pressure in lubricating-oil system	13.8 pounds.
Average double strokes, main air pumps	30
Average revolutions per minute, circulating pumps	112
Average temperature injection, degrees F	50
Average temperature discharge, degrees F	80
Total shaft horsepower	6,765
Pounds of water per hour per horsepower, all purposes	15.54
Nautical miles run per ton of fuel oil	6.328
Pounds of fuel oil per shaft horsepower per hour	1.319
Pounds of water evaporated per pound of fuel oil per hour	11.778
Draft, mean, on trial	8 ft. 5¾ ins.
Corresponding displacement	756.5 tons.
Speed per hour	25.21 knots.
Average revolutions per minute of turbines	489
Number of boilers used	4
Slip of propellers	17.13 percent.
12-hour, 16-knot speed trial:	
Average pressure at boilers, gage	264.5 pounds.
Average pressure at engine room, gage	252.5 "
Average pressure at auxiliary exhaust, gage	8.6 "
Nozzles open in each turbine	2
Average pressure at turbine steam chest, gage	193 pounds.
Average pressure at first ahead stage, gage	4.1 "
Average vacuum	28 inches.
Average pressure in fire room, inches water	1.41
Average revolutions per minute, forced-draft blowers	1,222
Average pressure in lubricating system	14.5 pounds.
Average double strokes, main air pumps	34
Average revolutions per minute, circulating pumps	—
Average temperature, injection, degrees F	50
Average temperature, discharge, degrees F	66
Total shaft horsepower	1,596
Pounds of water per hour per horsepower, all purposes	20.9
Nautical miles run per ton of fuel oil	12.9
Pounds of fuel oil per shaft horsepower per hour	1.77 pounds.
Pounds of water evaporated per pound of fuel oil per hour	11.81 "
Draft, mean, on trial	8 ft. 6½ ins.
Corresponding displacement	765 tons.
Speed per hour	16.26 knots.
Average revolutions per minute of turbines	298
Slip of propellers	12.22 percent.

The Bureau of Navigation reports 59 sail and steam vessels of 7,341 gross tons were built in the United States and officially numbered during the month of December, 1910. Three steel steamers, aggregating 671 gross tons, were built on the Atlantic and Gulf coasts, and three steel steamers, aggregating 3,574 gross tons, were built on the Great Lakes. There was also one steel steamer of 2,183 gross tons built on the Pacific Coast.

For the six months ending Dec. 31, 1910, the Bureau of Navigation reports 589 sail and steam vessels of 137,568 gross tons were built and officially numbered. This, as compared with 562 vessels, aggregating 82,425 gross tons, which were built during the corresponding period of 1909, shows an increase of 4.8 percent in number and 67 percent in tonnage.

THE MARINE STEAM ENGINE INDICATOR—XVIII*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

The value of $p\ v$ may be determined by taking co-ordinate measurements at any point on the curve and the curve traced by solving the equations for p only or for v only. But a little thought will show that the curve can be more accurately laid down when we solve for that dimension, which will be as near at right angles to the curve as possible. For instance, the curve of Fig. 101 (see January issue) will be more accurately determined for the point $v = 2$ and $p = 50$[1] when we solve for v instead of p, because the curve is quite steep at this point, and a small error in p would cause a large horizontal displacement of the curve from its true position.

A simple rule for solving for p only is as follows: *Multiply the absolute pressure at the point of cut-off by the fraction made by writing the number of inches of the stroke completed at* CUT-OFF *as a numerator over the number of inches of stroke completed at that point as a denominator.* For example, suppose that we have an engine of 32 inches stroke, cutting of at

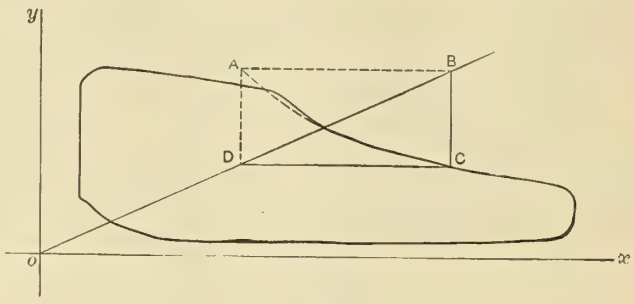


FIG. 102.

16 inches, the initial pressure being 100 pounds. The pressure at cut-off will be $100 \times 16/16 = 100$; at 20 inches, $100 \times 16/20 = 80$; at 24 inches, $100 \times 16/24 = 66.6$; at 28 inches, $100 \times 16/28 = 57.1$, and at 32 inches, $100 \times 16/32 = 50$.

The curve may be laid out geometrically in a number of ways, but only one method will be noticed here as being of general use in indicator work. Let C (Fig. 102) represent *any* point on the hyperbolic curve. Draw $C\ D$ parallel to $O\ X$. From O draw $O\ B$, cutting $C\ D$ at any desired distance from C. Draw $B\ C$ "square" with $C\ D$, producing it to cut $O\ B$ in B. Complete the rectangle, as shown by the broken lines $A\ B$ and $A\ D$. The curve will pass through A and C. By drawing a sufficient number of these rectangles the whole curve may be laid out from a single point. Great care must be taken to locate O accurately.

Heat and work are mutually convertible. One heat unit being equal to 777.5 foot-pounds.[2] If we had an ideal engine so constructed that no heat could enter or leave the working gas through the cylinder walls or piston, or through any of their attachments, we should find that the temperature of the gas would fall in spite of the non-conductivity of the cylinder. The gas in expanding and driving the piston ahead of it would convert a certain part of its heat into mechanical work, and in the ideal engine the loss of heat would be the exact equivalent of the work done at the cross-head. This would cause a continual decrease in the gas temperature as the piston advanced, and as all gases contract in cooling it is readily seen that an expansion curve made under these conditions would fall below the hyperbola or constant temperature curve. This type of curve is known as an *adiabatic,* or curve of no transmission of heat, and derives its name from two Greek words

* Copyright, 1911, by Chas. S. Root.
[1] See September, 1910, issue, page 379.
[2] The mechanical equivalent of heat according to Marks and Davis.

signifying "not passing through." The equation of this curve is $p\ v^{10/9} = constant$. It cannot be traced by computation without the aid of logarithms, and its geometrical construction is too tedious to be of general use.

When steam is formed in a vessel in contact with water, it has a certain definite pressure and temperature[3] and is said to be *saturated*. If, at the same time, it holds no liquid in suspension in the form of spray it is said to be *dry and saturated*. Curve No. 2 (Fig. 101) shows the relation between *volume* and *pressure* for dry and saturated steam. This curve is readily traced from any steam table by taking the weight of steam involved and multiplying this weight by the specific volume[4] at the different pressures. The product is the volume corresponding to the pressure at which the specific volume was taken. For example, 1 cubic foot of steam at 100 pounds pressure weighs .2258 pound[5]. The specific volume at 50 pounds absolute pressure is 8.51, and the actual volume of 1 cubic foot at 100 pounds expanded to a pressure of 50 pounds is .2258 × 8.51 = 1.92 cubic feet. This locates a point on the curve at $v = 1.92$, $p = 50$. A curve may also be computed with close approximation to the above by means of the equation $p\ v^{10/9}$ = constant, and its actual computation will be taken up when we come to consider the use of logarithms. This curve could be reproduced on an indicator diagram if dry-saturated steam were admitted to a jacketed cylinder if just enough heat could be added to keep it dry and no more.

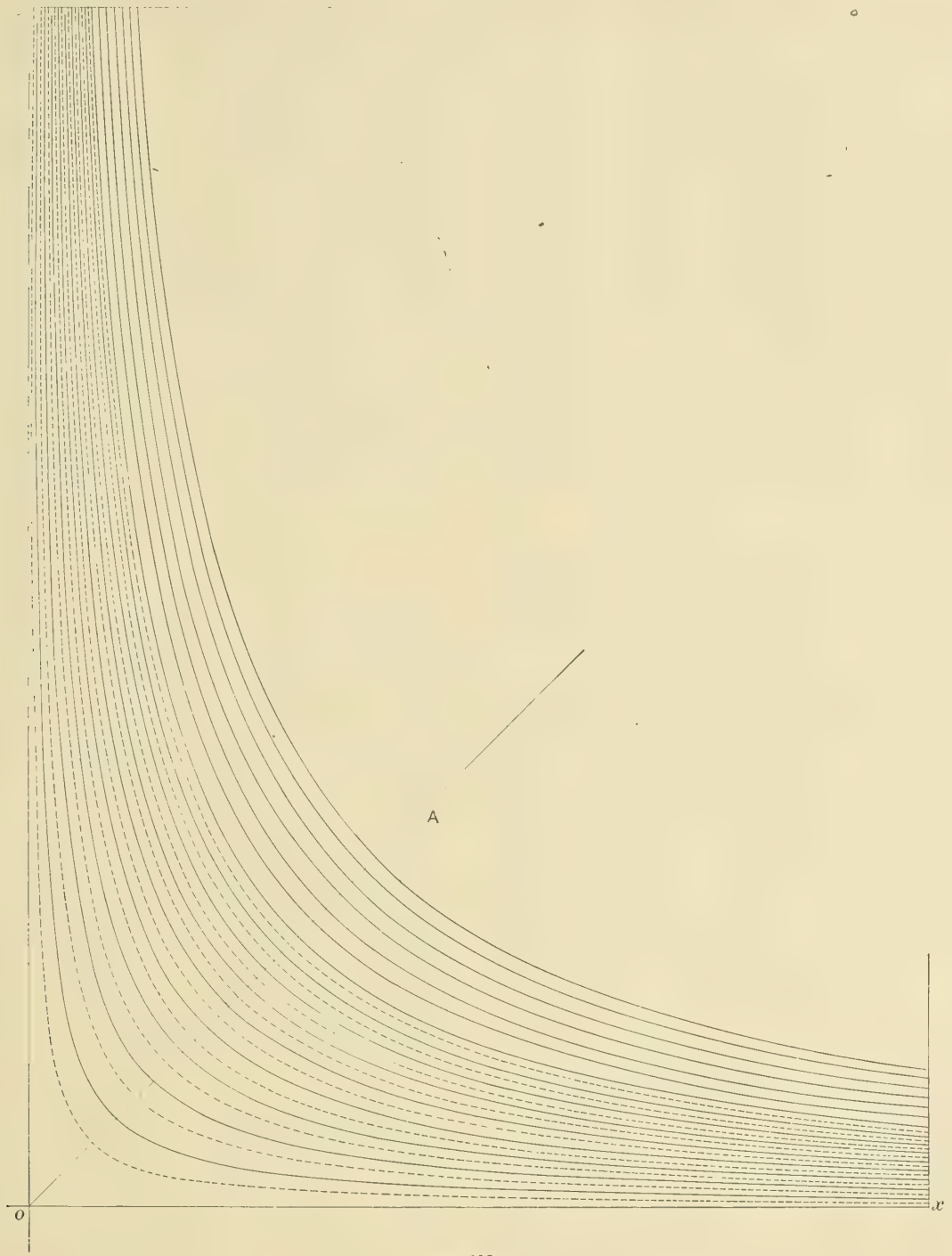


FIG. 103.

Superheated steam is steam whose temperature is greater

[3] See page 380, September, 1910, issue, Fig. 94.
[4] Cubic feet per pound.
[5] Tables of Marks and Davis.

than that of saturated steam of the same pressure. Curve No. 4 (Fig. 101) represents adibatic expansion of superheated steam where the superheated condition continues to the end of the stroke. The equation of this curve is $p\ v^{1.3} = constant$. To attain such a result a high degree of initial superheat would be necessary. Curve No. 5 is the adiabatic for dry air.

With 100 pounds absolute pressure and ten expansions, the mean pressures for the various curves shown in Fig. 101 would be as follows:

Isothermal, $p\ v = constant$.....33 pounds
Saturation, $p\ v^{17/16} = constant$.....31.4 pounds
Adiabatic, dry steam, $p\ v^{10/9} = constant$.....30.3 pounds
Adiabatic, superheated steam, $p\ v^{1.3} = constant$, 26.6 pounds.
Adiabatic, dry air, $p\ v^{1.4} = constant$.....24.5 pounds

From the above table it will be noted that the superheated steam diagram shows the lowest mean pressure of any of the steam diagrams, and any reader who has served on a vessel fitted with a superheater will at once recognize the phenomenon. It is a matter of common observation that an engine working with saturated steam will slow down immediately the steam is passed through the superheater, even though the pressure at the throttle remains the same. If it is desired to maintain the same speed as before, it is necessary to run the links out for a later cut-off. This is in accordance with the fact that superheated steam will give out less work per *unit of volume* than saturated steam[6] if the latter is kept dry to the end of the stroke, all of which is in agreement with the diagram.

When steam first enters a cylinder at the beginning of the stroke it strikes surfaces which have just been exposed to the temperature of the exhaust and a portion of it is immediately condensed, its place being immediately taken by fresh steam from the valve chest. This is termed *initial condensation*, and if the ports and passages are ample no pressure drop will be indicated on the diagram. After cut-off takes place condensation will continue until the temperatures equalize, and this will show on the diagram by the expansion line being somewhat lower than the theoretical curve. As expansion continues, the temperature of the steam will drop below that of the metal parts of the cylinder and piston, and some of the water of the initial condensation will *re-evaporate*. This additional steam will add to the pressure and raise the expansion line above its computed position. If the steam is superheated on entering, or if the cylinder walls are kept above the initial steam temperature by some means external to the cylinder, the cylinder condensation will be eliminated in whole or in part, and the curve drawn by the indicator will closely approach the $p\ v^{17/16}$ or the $p\ v^{10/9}$ curve.

The expansion curve is very liable to be altered in form by leakage into or from the cylinder. Fig. 102 shows a diagram taken by the writer from an old, single-cylinder marine engine, whose valves and piston were known to be leaky. But a glance at the diagram will show that the expansion line coincides almost exactly with the isothermal curve, which is also drawn on the card. Here various bad conditions have produced a good expansion line. If the valves only had leaked, the expansion line would have been higher than shown; while, if the leakage had been entirely at the piston packing, the line would have been considerably lower.

Owing to the many factors which affect the expansion line it is not well to attempt to judge of the tightness of pistons and valves by its position on the diagram. This is better determined in small engines by shoring the cross-head and testing under steam, and in large engines by running water on top of the piston and into the ports when the cylinders are open and noting the rate of leakage.

[6] For any given *unit of weight* superheated steam contains more heat and will give out more work.

The various theoretical curves are of value as a basis for comparison, but unless the diagrams form a part of a very precise and elaborate test, the work of laying down any but the isothermal curve ($p\ v = c$) is not justified.

Relative to the equation for the adiabatic curve ($p\ v^{10/9} = constant$), Prof. C. H. Peabody says,[7] "There does not appear to be any good reason for using an exponential equation in this connection, and the action of a lagged steam-engine cylinder is far from being adiabatic. * * * For general purposes the hyperbola is the best curve for comparison with the expansion curve of an indicator card."

For the purpose of quick and easy comparison, if much of such work is to be done, it is convenient to have drawn and ready to hand a number of hyperbolic curves, as shown in Fig. 103. These should be carefully laid out on paper and afterwards inked in on tracing cloth.

The axis of x or base should be 10 inches long and the axis of y about 13 inches; only that part of the hyperbolas above the diagonal $O\ A$ need be computed, as the other half is a duplicate for the lower 10 inches of the upper side. The diagram should be made of the size indicated, so that it will be of use when working with large combined diagrams as well as with small cards. To use the tracing, the *clearance line and line of zero pressure must be carefully drawn on the card.* The tracing may then be placed over the indicator card, so that $o\ x$ and $o\ y$ will coincide with the reference lines drawn on the card. The actual expansion line will show through and may be easily compared with the hyperbolic curve.

(*To be continued.*)

Gas Power for Marine Propulsion.*

The future of gas power for marine propulsion looms big on the horizon. Much has been written of the producer-gas system, but it must be confessed that the oil-burning engine is more attractive from the standpoint of convenience and compactness. The advantage of storing oil in the ship's double bottom is great from a standpoint of cargo capacity. European countries have been active in this development: Russia with its tank ships, France with its submarines and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland waterways of Europe, where coal is the cheaper fuel, and a boat is being equipped here for service in New York harbor.

Recently the announcement has come of the adoption of oil engines for the 8,000-ton, 12.5-knot freight boats now being built by the Hamburg-American Line. These will be equipped with two 1,500-horsepower Diesel engines built by the Augsburg and Nurnberg works, and if the experiment is successful passenger vessels will be constructed. One American builder, at least, has taken up the Diesel engine for marine work.

The annual Motor Boat Show for 1911, held under the auspices of the National Association of Engine and Boat Manufacturers, will open Tuesday, Feb. 21, at noon, and close Saturday, March 4, at 11 P. M. The Show will be held at the Madison Square Garden, New York City, and will be open daily from 9 A. M. to 11 P. M., excepting Sunday.

Advice has been received from Rio de Janeiro that all the ten torpedo boat destroyers built for the Brazilian government by Messrs. Yarrow have now arrived there without the slightest mishap, either as regards the vessels or their machinery. The *Paraná*, the last of these vessels, reached Rio on the 18th of December.

[7] Thermodynamics of the steam engine and other heat engines.

* From an address on gas power development, by James Rowland Bibbins, before the American Society of Mechanical Engineers, December, 1910.

THE ECONOMICAL WORKING OF RECIPROCATING MARINE ENGINES AND THEIR AUXILIARIES.*

BY D. B. MORISON.

Never in the history of steamship owning has competition rendered it so difficult to earn an adequate return on invested capital as during the past few years, and as coal consumption is an important factor in the economics of a steamship, the present would seem to be a particularly opportune time for reviewing the systems on which main engines and their auxiliaries are worked, in order to elucidate by proposition and discussion the methods that favorably affect commercial results.

It is also appropriate that this question should be dealt with by an institution such as ours, for the reason that the membership includes not only engineers of acknowledged repute as designers and constructors, but also engineers who superintend the working of the machinery of large fleets, and whose opinions are based on prolonged practical experience.

Freedom from breakdown and minimum cost of upkeep are so imperative for successful ship management that marine engineers often hesitate to depart from standardized methods, but if this tendency be carried to excess, in these keenly competitive times, there is a danger that the traditions of apparently successful practice may be insidiously responsible for perpetuating systems of working which are technically unsound and commercially wasteful.

Considerable attention is now being given to the influence of vacuum on the steam economy of triple and quadruple marine engines, and as there appears to be diversity of opinion on the subject among marine engineers, it is well worth investigation.

The usual and traditional practice is to carry a low vacuum in the condenser, because it produces a high temperature of air pump discharge water, this practice being associated with the assumption that any vacuum above, say, 25 inches in the condenser is a source of waste in the steam economy of the engines, while a few inches less make no material difference, because the feed water becomes so much hotter.

In considering this question it must be remembered that from 15 to 20 percent more steam is generated in the boilers of a steamship than is supplied to the main engines, this amount being used in the various steam auxiliaries. If an auxiliary high-pressure engine, such as a fan engine or a steering engine, exhausts into a condenser, about 80 percent of the heat in the steam supplied to the engine is lost in the condenser, and if the engine exhausts into low-pressure receiver of the main engines, this percentage loss is approximately the same. In the latter case, however, the compound principle is introduced and the power developed by the steam ought to be obtained with more economy, but as considerable water is discharged into the receiver with the exhaust steam, and is often allowed to pass through the engine without being trapped, it is very questionable indeed whether much actual steam economy results from the arrangement. This is of very minor importance, however, compared with the fact that, if the heat in the exhaust steam from the auxiliaries can be absorbed by the feed water, the 80 percent, instead of being wholly wasted in the condenser, is wholly utilized by being returned to the boiler.

I need not deal at length with the quantity of steam used by the auxiliaries on shipboard, in view of the excellent paper on that subject recently read before the Institution of Engineers and Shipbuilders in Scotland by Mr. C. F. A. Fyfe, of Liverpool, but for purposes of illustration the following estimates may be taken as approximating the quantities used under average conditions at sea in a semi-passenger steamer of 5,000 indicated horsepower and a cargo steamer of 1,500 indicated horsepower.

TABLE I.—SEMI-PASSENGER STEAMER, 5,000 I. H. P.

Estimated steam consumption, 14 lbs. per I. H. P. per hour = 70,000 lbs. per hour.
Pressure maintained in exhaust steam receiver = 2 lbs. per square inch.

HEAT UNITS AVAILABLE IN THE EXHAUST STEAM AND WATER DRAINAGE FROM AUXILIARIES.

AUXILIARIES.	Pounds Per Hour.	Temperature.	B. T. U.
Evaporator steam at 6 tons per 1,000 I. H. P. per 24 hours	2,800	218	3,304,000
Water drainage from evaporator coils	3,360	259	870,240
Water drainage from I. P. casing discharged by water trap, estimated at 3 percent at 50 lbs. pressure	2,100	298	625,800
Steering engine exhaust	1,000	218	1,180,000
Independent feed pump exhaust	950	218	1,121,000
Independent circulating pump exhaust	1,800	218	2,124,000
Fan engine exhaust	1,300	218	1,534,000
Electric light engine exhaust	800	218	944,000
	14,110	....	11,703,040

Vacuum in condenser ..... 28.25 ins.
Temperature of feed water discharged by air pump ..... 87 degrees

BEFORE MIXING.

B. T. U. in feed water = 70,000 × 87 ..... = 6,090,000
B. T. U. in auxiliary exhausts and drains ..... = 11,703,040

Total B. T. U. ..... = 17,793,040

AFTER MIXING.

$$\text{Temperature of feed water} = \frac{17{,}793{,}040}{(70{,}000 + 14{,}110)} = 211 \text{ degrees}$$

TABLE II.—CARGO STEAMER, 1,500 I. H. P.

Estimated steam consumption, 14 lbs. per I. H. P. per hour = 21,000 lbs. per hour
Pressure maintained in exhaust steam receiver ..... = 2 lbs. per square in.

HEAT UNITS AVAILABLE IN THE EXHAUST STEAM AND WATER DRAINAGE FROM AUXILIARIES.

AUXILIARIES.	Pounds Per Hour.	Temperature.	B. T. U.
Evaporator steam at 7 tons per 1,000 I. H. P. per 24 hours	980	218	1,156,400
Water drainage from evaporator coils	1,176	259	304,584
Water drainage from I. P. casing discharged by water trap, estimated at 3 percent at 50 lbs. pressure	630	298	187,740
Steering engine exhaust	380	218	448,400
Electric light engine exhaust	300	218	354,000
	3,466	...	2,451,124

Vacuum in condenser ..... 28.25 ins
Temperature of feed water discharged by air pump ..... 87 degrees

BEFORE MIXING.

B. T. U. in feed water = 21,000 × 87 ..... = 1,827,000
B. T. U. in auxiliary exhausts and drains ..... = 2,451,124

Total B. T. U. ..... = 4,278,124

AFTER MIXING.

$$\text{Temperature of feed water} = \frac{4{,}278{,}124}{(21{,}000 + 3{,}466)} = 175 \text{ degrees}$$

The highest temperature water the ordinary single acting marine ram feed pumps will draw with the usual small head is 170 degrees. But if the head is increased as by an elevated direct contact heater, an independent float controlled feed pump will deal with the water at as high temperature as exhaust steam at a pressure slightly above atmospheric can heat it, so that in both the above examples it is possible to raise the entire feed water to a temperature exceeding the pumping limit by condensing among it exhaust steam from the auxiliaries, and this can be accomplished in association with a high vacuum in the condenser.

The all-important question, therefore, is, what is the influence of high vacuum on the steam consumption of triple and quadruple marine engines? I have very carefully examined data published by the leading authorities on this subject, and there is complete agreement that in a triple and quadruple engine having suitably designed and proportioned low pressure cylinder ports and exhaust passages the power of the engine increases

* Paper read before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, November, 1910. Appendices to the paper will be published in the March issue.

and the consumption of steam per brake horsepower decreases with approximate uniformity up to the highest vacuum that can be reasonably carried on a steamship, the rate depending on the ratio of expansion and the number of cylinders in which the expansion is effected; the order in economy in reciprocating marine engine practice being compound, triple, quadruple.

It is unnecessary to set forth all the supporting evidence, but reference may be made to the classical research on this question carried out by that eminent investigator, the late Mr. Willans, in which he definitely proved that in his central valve compound engine the consumption of steam per brake-horsepower decreased with increased vacuum at the rate of fully 1 percent per inch up to 27 inches, which in those days was considered a high vacuum for compound engines and was the high limit of the experiments.

Dr. Mellanby has also favored me with the results of vacuum tests (Appendix A) made on the compound engine at the Technical College, Glasgow, and which confirm the experiments made by the late Mr. Willans.

In order to ascertain the latest practice of the builders of land engines, I asked Mr. R. K. Morcom if he would communicate to our Institution the results of one of his firm's triple expansion engines, and I am greatly indebted to Messrs. Belliss & Morcom for the complete report of an engine trial, as set forth in Appendix B. It is worthy of record that every engine manufactured by this company is thoroughly tested under all loads by a trained staff and with the whole equipment necessary for obtaining the greatest accuracy, the methods employed being those recommended by the Institution of Civil Engineers Committee for steam engine and boiler trials.

Broadly, Mr. Morcom shows that in a Belliss triple-expansion high-speed engine the increase in steam consumption per brake-horsepower is at the rate of 1.77 percent per inch of decrease in vacuum from 28 inches down to 21.5 inches, which were the high and low limits of the tests.

With a view of meeting the objections of those marine engineers who hesitate to be guided by land engine results, I recently presented to Armstrong College a new low-pressure cylinder with enlarged ports and passages for the quadruple marine type engine on which so much valuable research work has been carried out in the past, and we are once again indebted to Professor Weighton for kindly offering to test the effect of this cylinder on the College engines under varying vacua when arranged as three-cylinder triples and four-cylinder quadruples. The cylinder was only fitted a few days ago, so that the exact results will be given by Professor Weighton at our next meeting, but the preliminary tests afford confirmatory evidence of the economy obtainable with high vacuum both in triples and quadruples.

It is difficult to obtain absolute accuracy from marine engines, but through the courtesy of the owners and their superintendents I am able to include in Appendices C, D, E the results of three representative types of steamships the engines of which which were designed for high vacuum, namely:

(1) Steamship *Indrabarah,* Australian twin screw frozen-meat steamer, with triple expansion engines of 5,000 indicated horsepower, by Richardsons, Westgarth & Co., Ltd.

(2) Steamship *Anglo-Patagonian,* cargo steamer, with quadruple expansion engines of 2,000 indicated horsepower, by Messrs. The North-Eastern Marine Engineering Co., Ltd.

(3) Steamship *Djerissa,* cargo steamer, with triple-expansion engines of 1,100 indicated horsepower, by Messrs. The Central Marine Engineering Co., Ltd.

The results are as communicated, the original logs are on the table and all the particulars were obtained with great care. On referring to the Appendices, it will be seen that the records in each case are exceptionally good, and as the Contraflo system of condensing and temperature regulation was fitted in each of the ships, it is clearly evident that the economical possibilities were realized and that the system contributed to the general excellence of the performances.

For the purposes of this investigation the points of interest are the vacua carried in the condensers and the pressures recorded on the low-pressure diagrams. Broadly, on voyage conditions in each of the three ships a condenser vacuum of 94 percent, or 28¼ inches (barometer 30 inches), can be carried in sea water of 60 degrees and 91 percent, or 27¼ inches vacuum in sea water of 80 degrees, and at these vacua the pressures recorded in the low-pressure diagrams are approximately 13 pounds and 12½ pounds, respectively, below the atmospheric line. The low-pressure diagram (Fig. 6) is representative of what can be obtained on an ordinary cargo boat at full power and was one of a series sent home by the chief engineer. The condenser vacuum was 27½ inches, the revolutions 60 per minute, and a pressure of 13 pounds is recorded below the atmospheric line. On the trials of the steamship *Indrabarah* the revolutions of the engines were 90 and the vacuum 28½ inches, and yet under these high-speed conditions the pressure on the low-pressure diagram was 13 pounds below the atmospheric line, so that within the range of ordinary practice the design and proportions of the low-pressure ports, passages and valves present no difficulty.

It is needless to dogmatize on these results, but there are many hundreds of steamships in which the condensers cannot carry more than 20 inches to 22 inches in the tropics, and in which there is no provision for the utilization of the heat in exhaust steam. If these condensers had been designed to carry 27 inches in the tropics, and if the engines had been suitably proportioned and the feed-heating arrangements adequate, the saving would unquestionably have been approximately 10 percent. There are, therefore, economic possibilities in reciprocating marine engines that have been allowed to remain latent, but which, nevertheless, afford definite opportunities for materially decreasing the coal bill and thereby increasing the profit-earning power on the capital invested in steamships.

The value and effect of vacuum have hitherto been so casually considered by marine engineers generally that it is difficult to ascertain from a ship's log what vacuum has actually been carried on a voyage, and it is still more difficult to ascertain the correct vacuum by consulting an ordinary vacuum gauge in an engine room. It is for this reason probably that trial trip data often include vacua observations so impossible as to reflect either a considerable elasticity of conception or a total disregard for natural laws.

In the absence of an acurate mercury column and such stability of ship as will enable a correct observation to be taken, I have found that to record the temperatures in, say, two places along a condenser top is preferable to reliance on the average vacuum gage, and chief engineers should always include these temperatures in their logs. All that is necessary is the permanent insertion of small brass tubular pockets in the condenser top in which the thermometers are placed among water or, preferably, mercury, and when the temperatures are recorded the corresponding vacua may be ascertained from the usual tables. This involves a slight inaccuracy, however, as the tables are based on the pressures and corresponding temperatures of water vapor and not of a mixture of air and water vapor. But as the amount of air at the top of a condenser above the tubes is, under normal conditions, very small indeed compared with the amount of water vapor, the inaccuracy is negligible and the method is certainly far more reliable for sea service than the indications of an ordinary vacuum gage. Records should not be taken for this purpose lower down in the condenser among or below the condenser tubes, because of the gradual increase in air pressure, there-

fore the temperature readings should be strictly confined to the exhaust pipe and the condenser top.

Since the publication of my investigations on surface condensers in 1904 and the paper read by Professor Weighton before the Institution of Naval Architects in 1906, the principles underlying efficiency have been better understood than previously. There are evidences that appreciation remains latent in some cases, but a perusal of Professor Weighton's paper and a comparison of the practice then and now will conclusively show that engineers generally are greatly indebted to him for a research which has proved of world-wide service.

While I am fully conversant with the possibilities of condensers having a relatively small amount of tube surface and a great amount of water passing through the tubes, such, for example, as are now permitted in warship practice, my long experience in mercantile marine engineering enables me to express my conviction that the warship proportions sometimes advocated for condensers on mercantile steamships fitted with reciprocating engines are not conducive to commercial success. The first essential in any condenser is such a disposition of the surface as will result in the greatest over-all efficiency, but the mere fact that a condenser has a large surface per horsepower is no criterion of its condensing capacity, because much of it may be ineffective, as is the case in the majority of the marine condensers at present in use. It is the treatment of the air in a condenser which is so vital to its efficiency, and from this point of view that condenser is the best which provides the air pump with air at maximum density.

Air pump efficiency is in effect a governing factor in any condensing plant, and although in turbine installations the quantity of air leaking into the system may and should be very small, yet in ordinary reciprocating engines it is normally considerable, and it is folly to assume that the tightness which can be obtained by careful tuning up on the trial trip will continue to be maintained under average working conditions at sea. Tropical sea water has also a highly prejudicial effect on air-pump capacity by reason of the smaller difference in temperature of the water flowing through the tubes and the aerated vapor outside the tubes in the lower part of the condenser. For example, with a vacuum of 28 inches and sea water at 50 degrees, there is a temperature difference of 50 degrees, whereas with a vacuum of 27 inches and sea water at 85 degrees there is a temperature difference of 30 degrees only, or 40 percent less. This physical fact is largely responsible for the great fall in vacuum that invariably takes place in the tropics, and so universal is this fall that marine engineers accept its evil consequence as inevitable; but they are by no means inevitable and can be overcome in an extremely simple manner.

Condensers and air pumps are interdependent, in that both must be efficient in order to produce the best available results. For stable conditions the amount of air entering a condenser in a given time must be the same as the amount withdrawn by the air pump in the same time, otherwise air would accumulate in the condenser and the vacuum would fall. Under all conditions there must always be air in every condenser, but its non-conducting properties are so very detrimental that in order to obtain the highest efficiency of heat transmission through the tubes the quantity of air which remains in a condenser should be reduced to an absolute minimum. The condensers shown in Figs. 1 and 2 are designed with this object.

Fig. 1 is a condenser for a torpedo-boat destroyer. It is cylindrical in section and is fitted with air-concentrating plates, so arranged that the velocity of the incoming steam drives the air uniformly towards a very narrow outlet, where it is very highly concentrated and densified. Another result of the guide plates is that much of the water of maximum temperature formed in the upper part of the condenser is caught on the

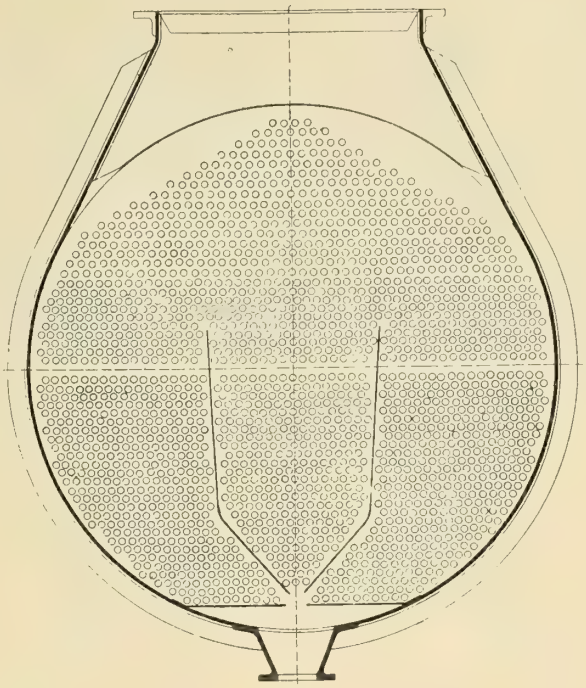


FIG. 1.

plates and is prevented from producing undesirable effects lower down.

Fig. 2 illustrates one of the main condensers for the turbine steamer *La France,* built by Messrs. Chantiers de L'Atlantique, St. Nazaire, and containing 21,000 square feet of tube surface. This condenser embodies a special devaporizing compartment and a water-charged receiver in the base of the condenser, to which further reference will be made.

Fig. 3 illustrates a condenser having a temperature regulator, and Fig. 4 its application to the engines of the steamship *Tamele,* owned by Messrs. Elder, Dempster, of Liverpool, and as the vessel trades in very hot waters the condensing plant enables a vacuum of 27 inches to be maintained in sea water of 90 degrees.

Although independent air pumps are necessary in turbine ships, yet in reciprocating engines the single air pump worked

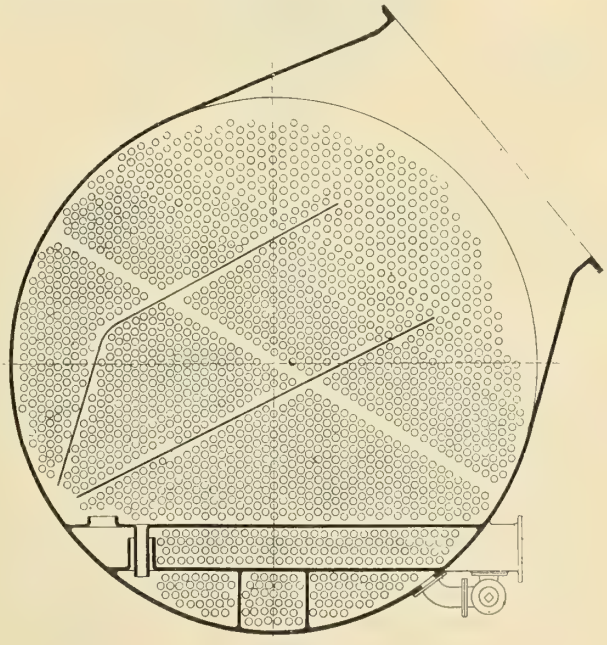


FIG. 2.

by levers from the main engines is still the standard practice, and long experience has proved it to be simple and reliable, requiring but little attention at sea and little cost in upkeep. This practice still prevails, even in the largest steamships, and it is of interest to note that the steamship *Balmoral Castle,* which has one of the latest and finest examples of reciprocating engines afloat, still retains the air pumps driven by the main engines.

The air-withdrawing capacity of any reciprocating air pump of given size depends on the difference between the vacuum that can be produced in the pump barrel on its suction stroke and the vacuum in the condenser. But if water of condensation entered the pump at the temperature corresponding to the vacuum in the condenser, it would obviously boil as soon as the pump bucket commenced its suction stroke and the re-

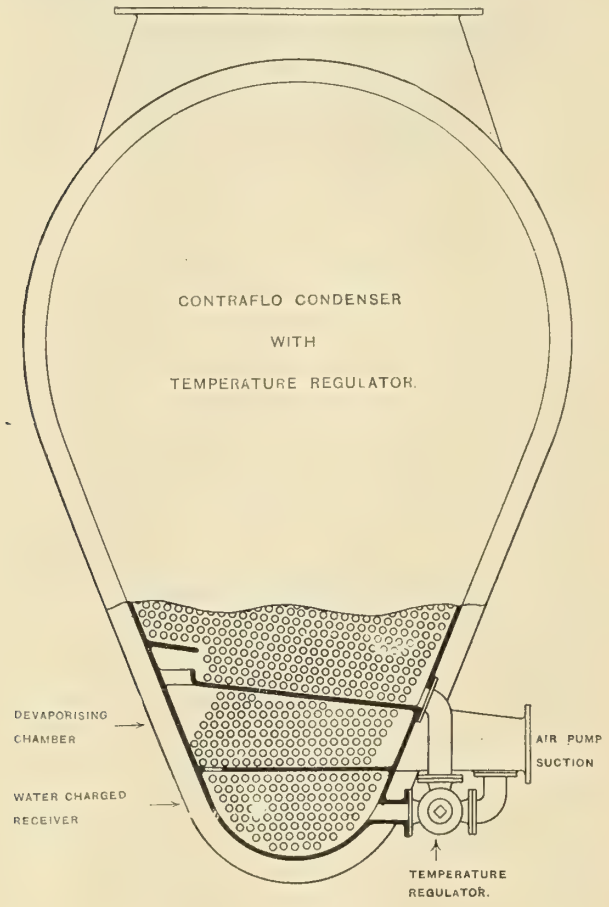


FIG. 3.

sultant vapor, by filling the barrel, would impair the inflow of air from the condenser. If, on the other hand, the water entering the pump were so cold that it did not boil during any portion of the vacuum-producing stroke of the air pump, then the vacuum produced in the barrel would be much higher than in the condenser and the flow of air into the pump would be a maximum. Therefore, an air pump can be rendered very flexible in air-withdrawing capacity by temperature, and if there are means for controlling the temperature, then the air-withdrawing capacity of a single pump can be regulated in accordance with the quantity of air to be withdrawn. The condenser illustrated in Fig. 3 contains a divided-off receiver in its base, which is always completely filled with water of condensation. At a distance above this water receiver is a diaphragm which catches the water of condensation formed in the condensing chamber above it. There is a pipe connecting the top of the water collecting diaphragm and the water receiver, and in the pipe there is inserted a two-way cock or valve, one way leading to the air pump suction pipe and the other to the water receiver. If there is a clear way between the water-collecting diaphragm and the water receiver, all the water of condensation passes through the receiver and is reduced in temperature before it passes into the air pump, the flow through the receiver being caused by the head represented by the distance the water-collecting diaphragm is above the receiver top. If, on the other hand, there is a clear way between the collecting diaphragm and the pump, all the water of condensation passes at a maximum temperature into the pump. The temperature of the pump, and therefore its air-withdrawing capacity, is under complete control by the partial or the full use of the temperature regulator, and extended experience has demonstrated that by this simple apparatus the vacuum can be raised in the tropics by from 1½ inches to 3 inches and often more, depending on the amount of air prevailing, and, at the same time, the air pump discharge water is kept at the highest temperature consistent with the maintenance of the highest available vacuum in the condenser.

Although manufacturers may fit abnormally large air pumps with the object of maintaining vacuum in the tropics, a considerable fall is inevitable in high temperature sea waters, unless the temperature of the air pump can be reduced below what is possible with the standard designs now in use. The temperature regulator naturally decreases the size of air pump necessary in all temperatures of sea water, but, in my opinion, an air pump driven by the main engine should in the mercantile marine be of sufficient size to deal with the normal amount of air when in sea water from 55 to 60 degrees, without the assistance of the temperature regulator. In such waters, therefore, the temperature regulator is very helpful when abnormal air leakage occurs, but in tropical temperatures it becomes a necessity, even with normal air leakages.

Referring again to the condenser designs fitted with air concentrators, it has now been shown that the withdrawing effect of an air pump can be greatly increased by reducing its temperature. But its function is to withdraw air, and it will withdraw air in maximum quantity only when the condenser delivers that air to it as free as possible from water vapor. Therefore the interdependence of air pump and condenser is obvious and the action of the one so influences the action of the other that both must be correctly designed if the available results are to be realized.

There are three accepted methods by which heat in exhaust steam can be absorbed by feed water, namely:

1. By steam nozzles submerged in a body of feed water on the suction side of the feed pump.

2. By the ordinary water-shower system in an elevated direct-contact heater on the suction side of the feed pump.

3. By a tubular surface heater on the discharge side of the feed pump.

For the purpose of this investigation let it be assumed that the condensing plant of a steamship fitted with reciprocating engines is able to maintain under voyage conditions 28¼ inches of vacuum in sea water of 60 degrees and 27¼ inches vacuum in sea water of 80 degrees, and that the water discharged by the air pump is 10 degrees below the vacuum temperature, or 87 degrees and 102 degrees respectively.

Fig. 4 shows one illustrative arrangement of the 1,500 indicated horsepower cargo boat proposition already referred to on page 57. The feed pumps are of the ordinary ram type, driven by the main engines, and if fitted with suction valves and passages suitably proportioned they will deal with water up to a temperature of 170 degrees without trouble. The water discharged by the air pump passes into what is known as a cascade feed heater and filter. Fig. 5 shows this apparatus in detail. The air pump discharge water flows into the first compartment, in which free oil, if there is any, floats on the surface and can be scummed off periodically. The water then

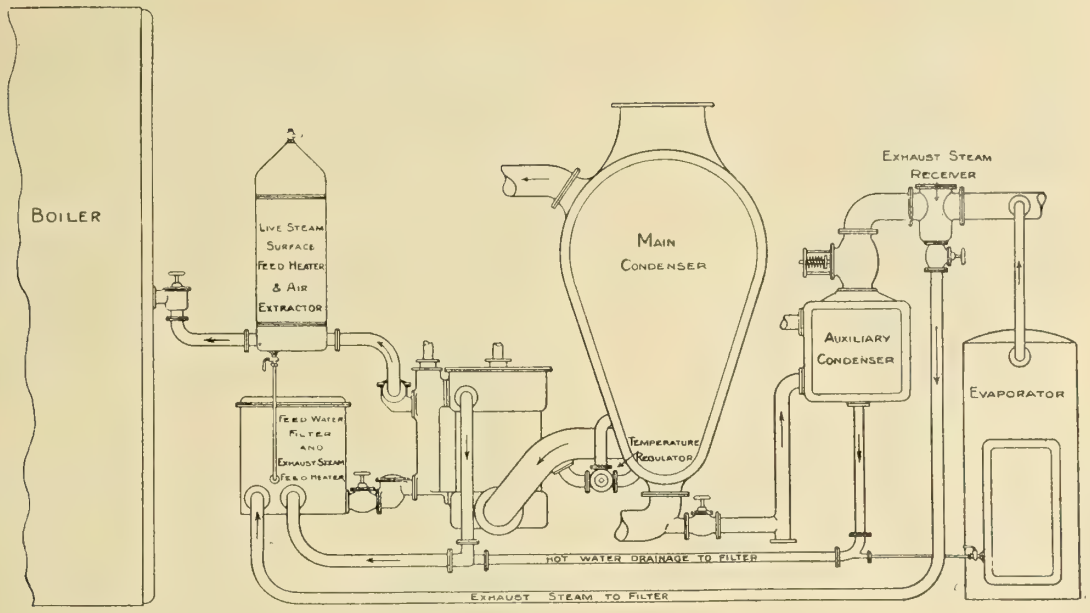


FIG. 4.

passes into a heating reservoir fitted with exhaust steam nozzles, thence it flows through a filter box into the final suction chamber, which is usually fitted with a float controlled valve, so as to prevent the feed pump from drawing more air than is actually required for cushioning purposes. Some air is necessary, and it can be admitted in controllable quantity by shifting the valve in the usual manner, but it is futile to expect the best available results either in boilers or engines if this air is allowed to pass into the boilers and back through the engine into the condenser. If there is a tubular heater on the pressure side of the feed pumps it should always be fitted with an air discharger, and if there is no such heater then the air vessel should be fitted with an air discharger. Fig. 7 shows a simple device for that purpose. The air, on passing from the air vessel, is discharged into an air collector of preferably conical form, so that at its base the inward and upward velocity of flow is much greater than the downward and outward flow. Air accumulates at the top, whence it can be discharged continuously through a small cock leading to the hotwell or filter, thus preventing the loss of the small quantity of water that flows out with the air.

The particular design of heater and filter (Fig. 5) was prompted by a desire to obtain a simple apparatus in which exhaust steam could be utilized (*a*) to heat a body of feed water quickly and (*b*) to afford an easy means for its filtration. In practice it is much favored by engineers at sea, as it gives them an excellent opportunity of watching the condition of the feed water as influenced by the use of an excessive quantity of oil or oil of inferior quality. All the exhausts from the auxiliaries, as well as the steam from the evaporator, discharge into a receiver, and between the receiver and the auxiliary condenser is an ordinary spring valve, loaded when at sea, to say, 2 pounds per square inch above atmosphere. Steam from the exhaust receiver flows direct to the heating nozzles in the heater and reference to Table II shows that it contains sufficient heat to raise the temperature of the feed from 87 to 175 degrees. But the pumping limit is 170 degrees,

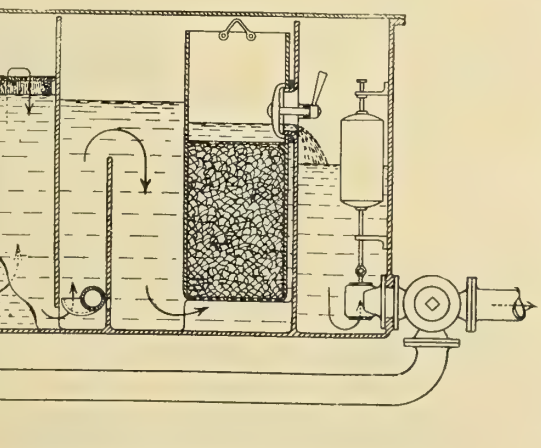


FIG. 5.—CASCADE FEED-WATER HEATER AND FILTER.

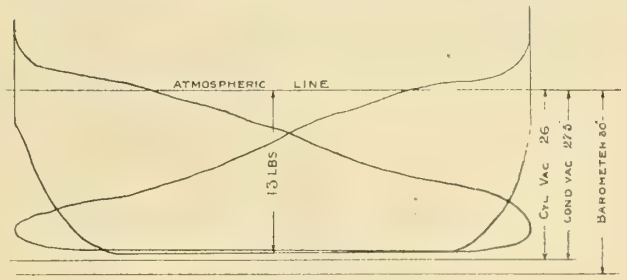


FIG. 6.

so that a small proportion of the available heat must be sacrificed. Of the total available heat, however, no less than 95 percent can be utilized for heating the feed water with a condenser vacuum of 28¼ inches and ordinary ram feed pumps.

There are two ways of dealing with the small amount of surplus heat. If the valve between the exhaust receiver and the heater is closed down a little, the surplus will flow into the auxiliary condenser. But it can perform a more useful function, as by opening the temperature regulator (Fig. 3) and allowing a portion of the water of condensation to pass through the water-charged receiver the temperature of the water discharged by the air pump can be so reduced that all the exhaust steam will be condensed in the heater without the pumping limit of 170 degrees being exceeded. This method increases the available capacity of the air pump for withdrawing air and is useful, even in low temperature sea water, if conditions are such that increased capacity is necessary. Now, suppose the vessel to be in tropical waters of 80 degrees, with a condenser vacuum of 27¼ inches and an air pump discharge

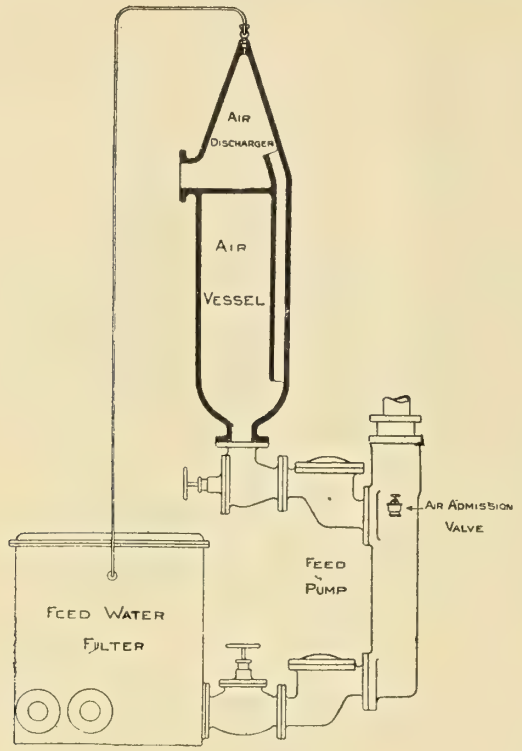


FIG. 7.

temperature of 102 degrees. If all the exhaust steam is condensed among the feed water, its temperature would be raised to 187 degrees or 17 degrees above the pumping limit, so that in this case 83 percent of the available heat is utilized. But under these conditions the air-withdrawing capacity of the air pump should be at the maximum possible, so that all the water of condensation can with great advantage be passed through the water receiver (Fig. 3) and the air pump discharge water so lowered in temperature that it will absorb all or the greater part of the surplus heat.

A live steam heater is shown in the illustration on the discharge side of the feed pumps, but its influence on economy does not come within the scope of this paper.

Fig. 8 illustrates a diagrammatic arrangement of the 5,000-horsepower proposition. In this case the feed pumps are independent and are supplied with water under control from an elevated direct-contact heater in the usual way. Reference to Table I will show that the heat in the exhaust steam and water drainage is sufficient to raise the temperature of the entire feed to 211 degrees under the conditions set forth, but as the heater is under atmospheric pressure the limit of temperature is about 207 degrees to 210 degrees, a temperature which is well within the pumping limits of the independent feed pump, so that in this case 98 percent of the available heat is utilized. At 27¼ inches vacuum the surplus heat is a little greater, but can be dealt with by the use of the temperature regulator as already explained.

It will be evident that the steam from the auxiliaries is somewhat oily, and this is especially the case with the deck machinery, so that if this particular arrangement is used in port it is very advantageous if the direct-contact feed heater is fitted with an oil separator. For port use the water from the feed tank has to be discharged into the elevated heater by an independent pump, which can conveniently be fitted near the filter tank and regulated by a float controlled valve therein.

Fig. 9 shows an arrangement having a tubular heater on the discharge side of the feed pumps. Both at sea and in port the auxiliary exhausts flow through this heater into the auxiliary condenser and thence into the filter tank. As the temperature of the water passing through the feed pumps is raised by water drainage only, it is so much below the pumping limit that no head on the suction side is necessary.

When using deck auxiliaries in port many engineers prefer the auxiliary condenser to be under a moderate vacuum. Fig. 10 shows a simple apparatus for that purpose. A centrifugal pump is employed for circulating sea water through the condenser, and on the same shaft is another small centrifugal pump which draws water from the filter tank and discharges it through a kinetic air ejector and again into the tank in continuous circulation. When this apparatus is applied for port use to the arrangement in Fig. 9, with the surface heater

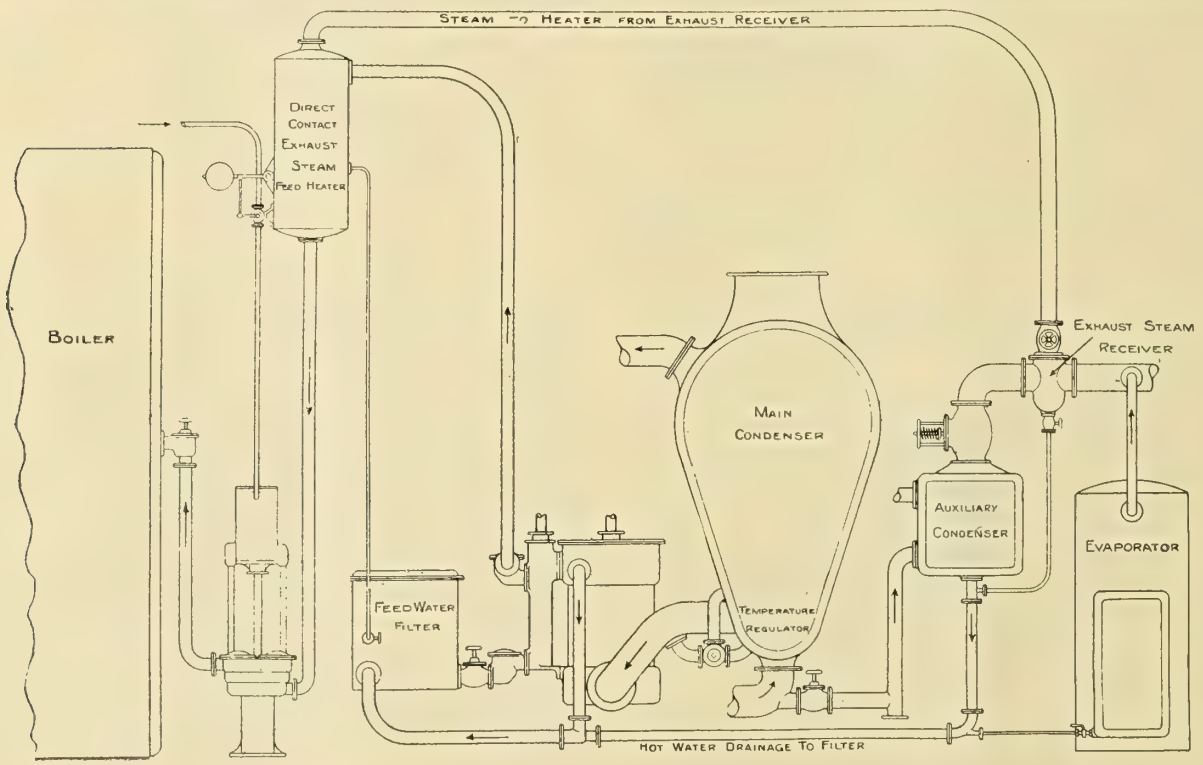


FIG. 8.

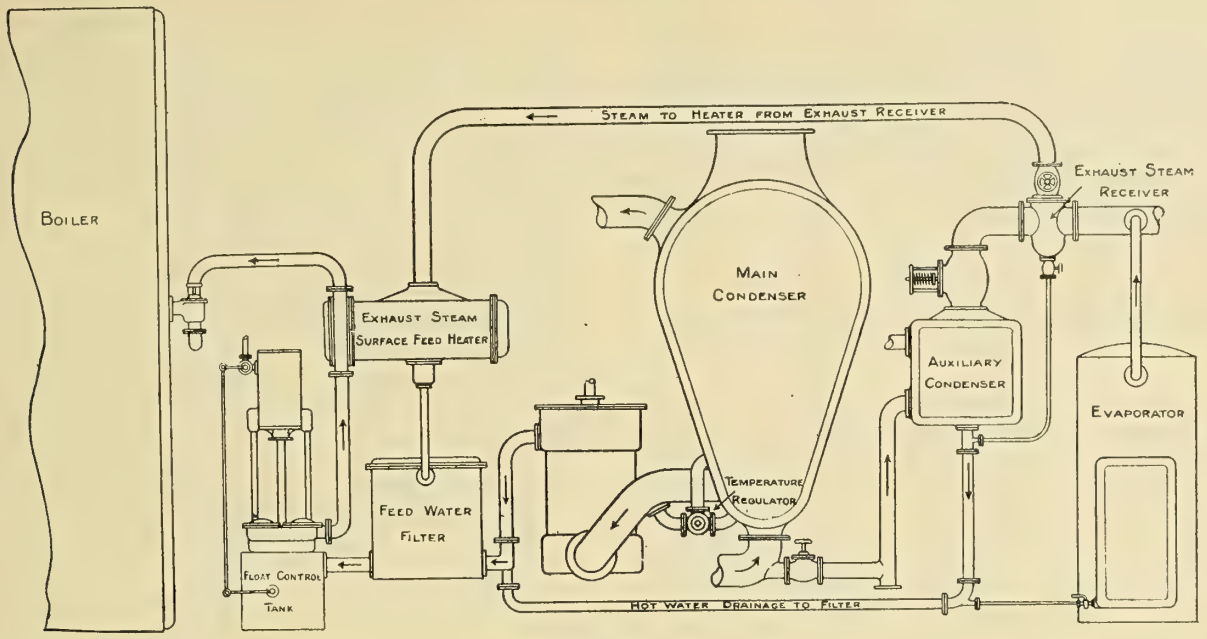


FIG. 9.

on the discharge side of the feed pump, the feed water is drawn from the filter tank by an auxiliary feed pump in the ordinary manner, but when applied to the arrangement in Fig. 8 for port use, and when the main engines are stopped, the water from the filter tank has to be discharged into the elevated direct-contact heater. For this purpose the pressure in the discharge pipe to the kinetic air ejector is maintained sufficiently high to force the water up into the contact heater. The amount of water discharged to the heater is, of course, equivalent to the amount condensed in the condenser, and its flow is regulated by a float control valve in the filter tank.

In such an arrangement the temperature obtainable is within a few degrees of the temperature corresponding to the vacuum carried, but as the heater, when of the direct-contact type, must be at such a height that the influence on the vacuum will not interfere with the satisfactory working of the feed pump, the vacuum should be moderate and should be controlled by the use of a spring valve, which admits air when the desired limit of vacuum is reached.

In all these arrangements the supply of exhaust steam from the steering engine, the ash hoist, the electric light engine and any auxiliary donkey that may be in temporary use is somewhat intermittent and irregular, but as the evaporator provides a considerable proportion of the entire low-pressure steam it can with great advantage be fitted with an automatic regulating valve, so that whenever the pressure in the exhaust receiver exceeds the assumed limit pressure of 2 pounds the steam supply to the evaporator coils is throttled and the supply of generated steam is immediately decreased. In this way the steam supply to the exhaust steam feed heater can be rendered uniform, notwithstanding that some of the auxiliary engines work irregularly or intermittently.

These calculations afford incontestable proof that the feed water in any steamship can be heated up to pumping limits by the available auxiliary exhaust steam; so that to ignore the economical possibilities of high vacuum in the engines and to work at a low vacuum in the condenser with the sole object of obtaining a high temperature of air pump discharge water, and then to throw away heat by deliberately discharging exhaust steam into the condenser because the feed water is already too hot to absorb it is, in my opinion, a system of working marine machinery that involves a considerable and continuous loss of available profit to the shipowner throughout the life of the ship.

The subject under consideration is one that directly appeals to the superintendent engineer, as while he cannot produce results beyond those which the machinery he controls is capable of giving, yet it is obviously his object to obtain initially such a design of machinery as is capable of yielding maximum

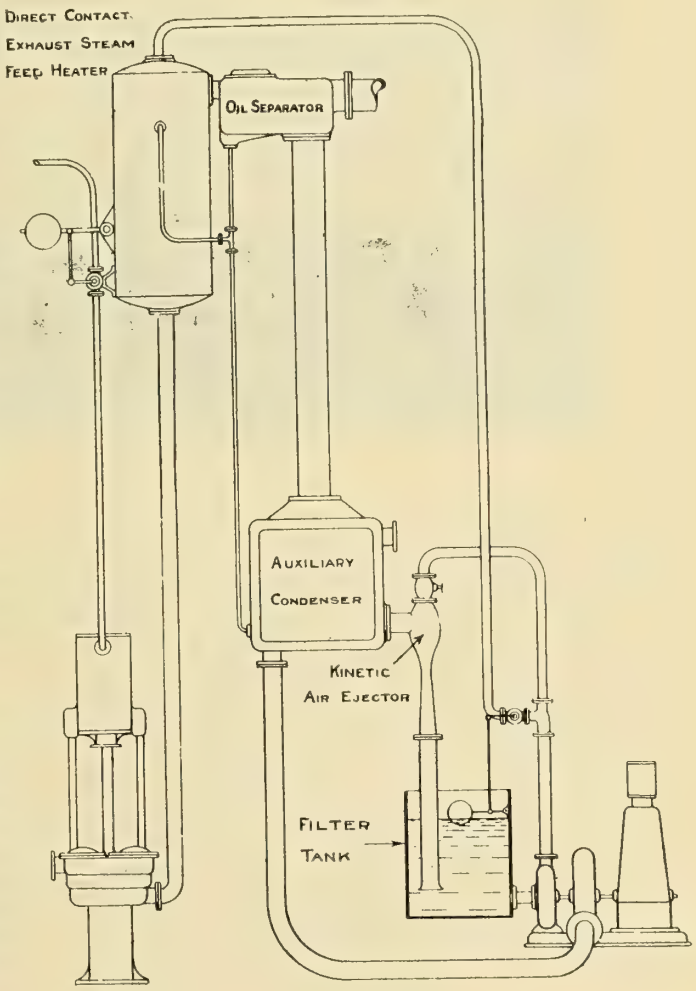


FIG. 10.

results, and then to work it so that his owners are placed in the best position for achieving maximum commercial success.

I therefore trust that, in the interest of engineering progress, the contributions to the discussion will be so liberal as to afford a solution to the question as to whether it is, or is not, commercially advisable to adopt a higher range of vacuum in reciprocating engines on shipboard than is at present customary, in combination with the heating of feed water by the exhaust steam from the auxiliaries.

THE GYROSCOPE FOR MARINE PURPOSES.*

BY ELMER A. SPERRY.

The uses of the gyroscope at sea fall properly under four general divisions: First, in affording means for resisting and preventing rolling of vessels or even rolling and controlling their motions at will; second, its use as a marine compass; third, for holding automobile torpedoes to their course; fourth, for artificial horizons in connection with observations at sea. There are two other uses which may be noted, that of recording the motions of ships, and also the use of a small gyroscope in controlling the oscillation of large active gyroscopes for purposes of preventing rolling motions of the ship in their inception, and thus holding the ship against rolling. The first three only will be treated briefly in this paper.

Previous to the introduction of the gyroscope, there have been three methods of steadying ships which afforded resistance to roll. "The oldest steadying gear," as pointed out by Sir John I. Thornycroft, "was probably the sail, though not originally intended for that purpose." He goes on to say "that the extended use of steam is depriving passenger vessels of this ancient steadying gear and causing increased rolling. For comfort at sea, we require in our ships some device that will afford resistance to roll, the need being an increasing one."

Lord Kelvin has measured angles of roll in crossing the Atlantic of 40 degrees each side of the vertical, giving a total angle of motion in a single roll of 80 degrees.

The early work of Froude, his co-laborers and successors, in applying athwartship tanks for prevention of rolling is well known. These, together with rolling ballast and the great moving weight of Thornycroft himself, all fall under the head of moving the center of gravity of the ship in attempting to balance the wave effect and prevent rolling.

About this time bilge keels were introduced and their characteristics are quite well understood, being effective only in heaviest rolling. Quite large bilge keels were found to equal about three-fourths of the surface hull and keel action for all angles of roll. The comparison between bilge keels and 1 percent of water ballast in athwartship tanks is interesting. Very large keels were found to be only one-eighth as effective at 3 degrees roll from the vertical, one-fourth as effective at 5 degrees roll, only equaling at 12 degrees roll, and being three times as effective at 18 degrees roll. They are also known to increase materially the resistance, skin friction and motive power required in all weathers. Sir John I. Thornycroft introduced a method of anticipating the rolling by the means of a controlling mechanism compounded of many active features involving a short and a long pendulum, a retarding device and a cataract all organized to co-act, these were operated on the floating link principle, a moving ballast being operated by heavy hydraulic machinery in the hold of the ship.

It is more than probable that the true engineering significance and the enormous power of the gyroscope were first discerned in this country; that is, observations concerning it were first made here in connection with early torpedo work.

The most extensive use of the gyroscope to-day is probably the automatic steering gear in Whitehead torpedoes. This gear is simply used for the purpose of lateral guiding of the torpedo and holding same to a straight course. This little gyroscope has a secondary ring which may precess—it offers positive resistance to any effort to turn it from its course, and this resistance is used to operate valves and, through a secondary motor, the rudders. This use originated with Obrey, an Austrian naval officer.

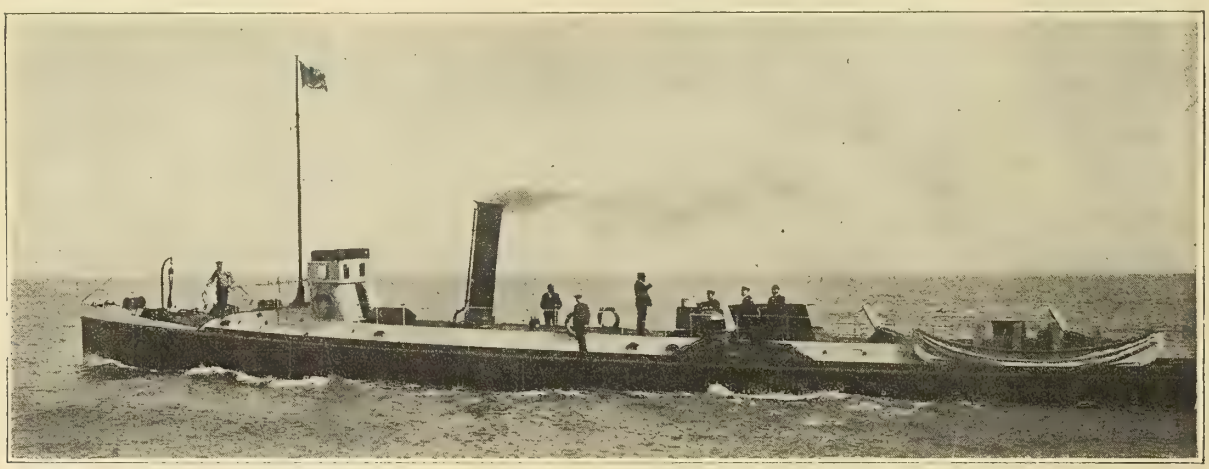


FIG. 1.—THE SEE BAR, THE FIRST STEAMSHIP EQUIPPED WITH A GYROSCOPE.

Our own member, Mr. Leavitt, engineer of the E. W. Bliss Company, of New York, and inventor of the Bliss-Leavitt torpedo, has greatly increased the efficiency of the "gyro" gear of torpedoes, as he has greatly improved the torpedo itself. Figuring from the increased speed and radius of action, he has increased the power factor of the old Whitehead torpedo twenty times and without materially increasing the air pressure carried. He accomplished this by a wonderfully bold piece of engineering; that is, by automatically burning a fuel directly in the pressure air current, thus greatly increasing its temperature. The reciprocating engine of the Whitehead is replaced by a pair of little Curtis turbines. It should be remembered that every doubling of the absolute temperature doubles the volume, and whereas he starts out with a small amount of air, he reaches the turbine with an immense quantity of air, under the requisite pressure, enormously increasing the power generated. an exceptionally interesting piece of engineering!

The Leavitt directing gyroscope is small, and he has increased its accuracy by unloading the base ring; instead of

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1910.

asking the base ring to do the work of moving a valve, he cuts the duty required down to about one-hundredth of that required in the Obrey gear, and makes it give a simple directive factor to an extremely small pivoted pawl at the instant the pawl is otherwise perfectly idle.

Dr. Schlick has done much in connection with the gyroscope. He is a noted engineer of Hamburg, Germany. It is to Dr. Schlick's genius that we largely owe the vibrationless reciprocating marine engine. This engineer has gone further in the installation of large gyroscopes for steadying ships than any other. His gyroscope is of the passive type. He is a practical engineer, and at first called to his assistance a number of other engineers and mathematicians and designed the first machine.

In Germany, in 1909, Engineer Dr. Frahm had succeeded in overcoming one of the reasons for eliminating the water chambers from the old English men-of-war—that was, the noise of the hundreds of tons of water rushing from side to side, which is said to have been intolerable—by using an inverted siphon. The trouble with this arrangement is that the central opening has to be of such a character as to cause the movement of the water to be synchronous with the boat's period; that is, in addition to the simple gravitational factor of the water the kinetic energy of the rushing water must be utilized; while the boat in still water has a fairly uniform period, and the movement of the water in the arrangement can be made to conform to a given period, however, in rough seas, the boat is not periodic, varying a great deal. I have seen automatic diagrams of rolling where the period varied from seven seconds to seventeen seconds. Now when the flow of this great quantity of water gets out of synchronism it becomes a menace, and makes the boat roll more and behave worse.

The great engineer, Sir John I. Thornycroft, of England, did much valuable work in attempts to overcome the last-named difficulty. He placed a great moving weight on a vertical axis which could move as a pendulum in the hold of the ship. An equipment of hydraulic apparatus was provided for swinging this weight from side to side. By this means the center of gravity of the ship could be changed at will. The weight was about 5 percent of the total displacement of the ship, but it was governed by the controlling apparatus mentioned above, in such a way that he succeeded admirably in anticipating all the needs of the ship up to the capacity afforded by this moving weight. The weight had the power of tilting the ship just 2 degrees either side of the vertical when swung to its extreme lateral positions. In sea trials of this arrangement, Sir William White states that it reduced 18 degrees of roll to 9 degrees. To eliminate wind and weather conditions the boat was made to sweep through an entire great circle in heavy seas. This was the first attempt to steady a ship by a controlled reactionary force. The difficulties encountered with this, the water tanks and all other gravitational methods, are that each pound of weight is enabled to do the work of only 1 pound, and the weights and auxiliary machinery required have been thought to be prohibitive; and, furthermore, the weight, when on one side or the other, constitutes a persistent unbalancing or listing force, whereas the gyroscope is enabled to deliver stresses pure and simple without disturbing the balance of the boat or introducing any such list whatever. The problem of preventing rolling of ships at sea has been attacked by a great many engineers.

Last year, while in Hamburg, Germany, I saw the latest arrangement by Engineer Frahm, installed on some naval vessels for the Russian government now being built with his arrangement for steadying ships, involving enormous tanks amidships, which will contain from 350 to 400 tons of water, through the rushing of which, back and forth, a part of the true periodic roll will be extinguished, but only a part and only when periodic. The eminent authority, Dr. Schlick, states with reference to this arrangement that it will become a positive menace and cause excessive rolling when the ship's oscillation falls out of period, which it invariably does in a storm. This, however, is interesting, as showing the great desire to prevent rolling of ships and especially war vessels.

The gyroscope, on the other hand, is not limited to any particular period of the boat; it simply responds to whatever motion the ship has—synchronous or non-synchronous. The question is often asked: Why is the gyroscope better than a moving weight in a ship for roll quenching? Barring the matter of list produced by the changes of center of gravity of the ship by the moving weight, the reason is perfectly apparent when you recall the magnitude of the stresses obtainable from a small machine. Every pound in the rotating mass of the gyroscope can easily be made to do the work of from 150 to 200 pounds, and directed in any desired line or plane, whereas, when we use water or any other form of moving weight, each

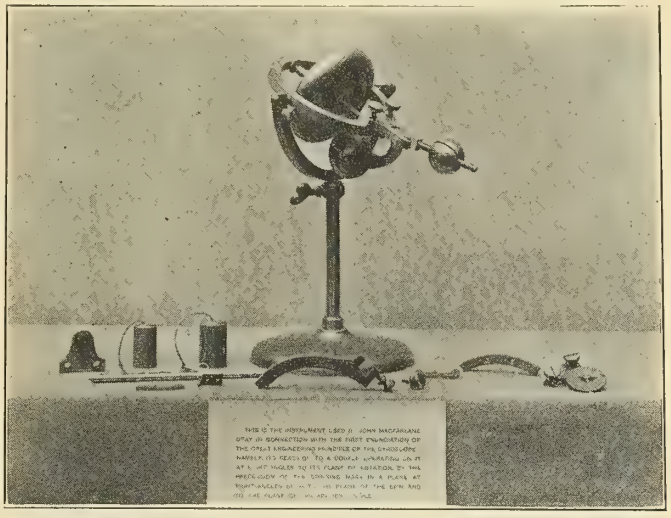


FIG. 2.—MODEL USED BY JOHN MACFARLANE GRAY TO DEMONSTRATE THE TRUE ENGINEERING PRINCIPLE OF THE GYROSCOPE. ORIGINAL NOW IN KENSINGTON MUSEUM.

pound represents a pound only, and can do the work of only a pound, and only in a vertical direction.

The gyroscope is probably the only device in the world by means of which stresses and also energy may be transferred "around a corner," so to speak. With the gyroscope it is possible to create and maintain a very powerful fulcrum in space effective for the heaviest kind of mechanical duty.

Now on board ship there is one factor that is stiff and is now available, and that is the fore-and-aft stability of the ship. In the gyroscope, for the first time, we have the means of rendering it possible to reach out and transfer this stability around a corner, so to speak, to the athwartship plane and thus hold the ship against rolling. We can do this with a surprisingly small mass, because, as I have said, every pound in that mass can be made to do a very large amount of work, owing to the velocity that may, at low cost, be impressed upon it.

A primary motion on the part of a body—for instance, the slow athwartship or rolling motion of a ship—exerts gyroscopic forces upon any vertical spinning shaft and in a fore-and-aft direction. These forces tend to dampen the rolling motion, but only feebly, and the fore-and-aft reaction, owing to the absence of motion, does not at all. It is a part of the general plan to so utilize this force as to make it create extremely large reactions athwartship or in the proper direction to be effective. This is accomplished by the ingenious yet simple expedient of mounting the aforesaid vertical shaft in a pivoted frame so that it can tilt and utilize the primary fore-and-aft reaction to cause the axis of the spinning mass to tilt fore and aft. This motion is of much higher velocity than the angular

motion of the vessel which produces it. By means of this tilting motion an entirely new gyroscopic force is set up, again at right angles as in the first instance, but now to the plane of tilt (fore and aft) which brings it back to the original athwartship plane just where needed; and, what is equally important, the reaction is in a direction exactly opposed to the roll of the ship which primarily called it into action, as well as this whole chain of phenomena which we have thus traced through a complete cycle of 180 degrees of angle, and also through an enormous augmentation of righting moment and stabilizing power.

The passive type of gyroscope fails to respond to all the smaller angles. It responds freely to the large ones or wide angle oscillations, but either does not respond at all or moves very slightly with the smaller oscillations, as stated. Not responding, it cannot, of course, control or extinguish these smaller oscillations. It being desired, especially in connection

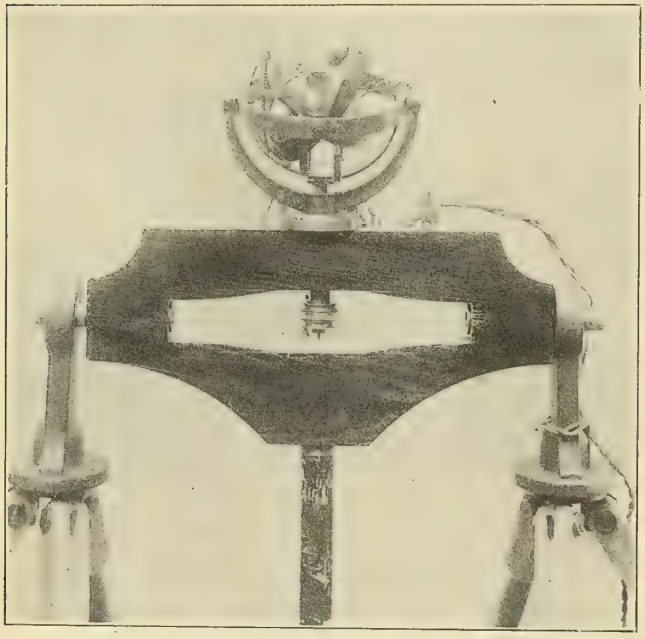


FIG. 3.—MODEL OF SPERRY GYROSCOPE USED TO DEMONSTRATE DIFFERENCE BETWEEN ACTIVE AND PASSIVE TYPES.

with improvement in conditions for gunnery on battleships and war vessels generally, that the gunner should operate if possible from a level gun platform, it therefore becomes desirable to act on these smaller oscillations of roll of the ship so as to completely extinguish them and hold the ship on a practically even beam. This especially as now all the larger war vessels are designed for broadside service and volley fire. The gunner, therefore, is compelled to keep an absolutely true and incessant aim upon the target. If the ship is rolling much or little this is a more difficult task. Again, the recoil of the volley fire throws the boat over and sets up rolling, and it is the duty of the gyroscope to extinguish and prevent all rolling disturbances, from whatever source. As we have seen, the lesser angle rolling cannot be taken care of by the passive type of gyroscope. We must rely upon the active type. By this means the full angle operation of the gyroscope is secured where necessary, independently of the amount of motion, or, in fact, any motion whatever, on the part of the ship, and is therefore in readiness to deliver to the boat stresses which are equal and opposite to those received by the boat from any source and prevent them from causing the boat to roll.

It is interesting to note that when the boat is held free from motion, as by the delivery of stresses equal and opposite to balance the wave effort, no power is required to actuate the gyroscope other than to overcome inertia and friction, which is almost negligible. When the roll is being suppressed and the boat is moving then the boat is doing work upon the gyroscope, and it then becomes the province of the actuator to emplace the oscillations of the gyro properly with reference to those of the boat, and at such angular velocity as to best suit the conditions, structure and mountings.

The work of Sir John I. Thornycroft for preventing rolling involved changing the center of gravity of the vessel, and thus introduced an additional disturbing and unstabling element which required additional treatment; his device involved a great moving weight running as high as 5 percent of the total displacement of the boat, and a very large amount of hydraulic machinery for handling these weights and a considerable amount of motive power for operating them. But with the active type of gyroscope, we find that a small part of 1 percent of the displacement of the ship will perform a very substantial service, down to the point of practically fully extinguishing the rolling. By the use of this device there is entire absence of any shift of the center of gravity of the vessel, and its stability remains unchanged. The sizes, weights, speeds and location of a gyroscope for this purpose are among the points which have been canvassed in tests carried on at the Washington navy yard during the past year.

Experiments were made with a working model of a 26,000-ton battleship of the super-Dreadnought class, with 5 feet metacentric height and eighteen seconds period of roll, capable of rolling through a total arc of 60 degrees; means were provided for autographically recording all motions, both of the ship's model and the gyroscope, upon same. The gyroscope was operated both passively and actively; means were also provided for emplacing the discharge of the active gyroscope variously with regard to the ship's oscillation, so that the effect of different combinations might be studied. Many other auxiliaries were provided, one of which permitted the actual velocities of the gyro wheel to be counted while in operation. This was accomplished by the stroboscopic apparatus of Capt. D. W. Taylor, similar to that used by him in his investigations of propellers under service conditions; in fact, both the ingenuity and reliability of performance of the model ship and the auxiliaries are directly due to Capt. Taylor and his assistants at the Washington navy yard. By means of this very complete equipment studies and records have been made and charts of performance prepared and other valuable data accumulated, much of which is new, as many of the observations, we believe, were never before undertaken. The investigations with the active type of gyroscope are in a new line of research; the results obtained are important in point of much more perfect control of the ship's roll than heretofore possible.

Capt. Taylor has prepared a very full report upon this work, forming a part of which is a 40-page appendix, in which he treats the question in a most masterly manner under some sixteen heads. In this most unique and valuable work, Capt. Taylor has given an original mathematical treatise on practically all the phases and bearings of this question, including an original investigation of the underlying phenomena of the gyroscope itself. It is of the greatest value to this important art that its problems should have come under the observation and been reviewed by so able a mathematician, experienced in all branches of experimental research, and fitted by long training to judge of the practical bearings of the results extending, as does this experience, to the very largest undertakings and structures in marine work. It is to be hoped that the author himself may be prevailed upon to give the society a paper including this valuable treatise.

The practical effect in operation of the active type of gyroscope is to secure a large reduction of weight over and above that possible with the passive type. With the passive type with the smaller angles of roll, the gyroscope would have to be large enough so that its small angles of response would

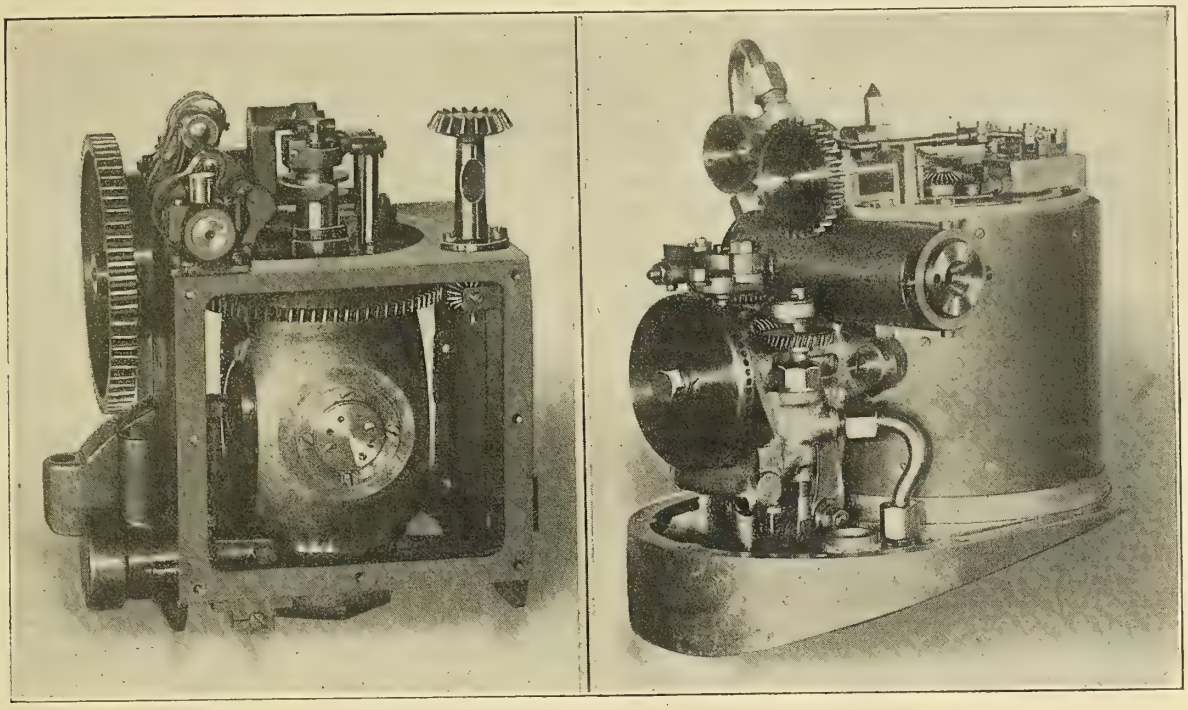


FIG. 4.—TWO TYPES OF LEAVITT GYROSCOPE USED IN THE BLISS-LEAVITT TORPEDO.

develop the required energy for extinguishing or still further reducing the roll, complete extinguishment being impossible; whereas with the active type the full 180 degrees oscillation of the gyroscope is always available, where required, for the extinguishment of large or even the smallest angles of roll as necessary. Thus an extremely small machine, taking advantage of the larger angles, between twenty and thirty times as large, is sufficient to accomplish this purpose.

Fig. 5 illustrates three curves, one at the top giving the number of oscillations of the ship's model before it was brought to rest by the natural friction, having been originally tilted to 25 degrees to one side of the center. The shorter or central curve illustrates the number of oscillations of the model with the gyroscope acting passively or on Dr. Schlick's plan, the several rolls of smaller magnitude at the end being omitted where the passive type of gyroscope failed to respond; and a still shorter curve at the bottom shows the number of oscillations of the ship in being brought to rest, absolute freedom from motion being possible by the same gyroscope when operated actively. These are among the interesting results reached in the investigations referred to above.

When the motive power of vessels changed from an upsetting force to one almost exclusively of forward thrust, the design of ships underwent quite radical changes in connection with lines affecting the stability, decreasing this factor and favoring decreased resistance, aiding the attainment of higher speeds. Now that stability may be imparted to a structure of naturally small righting moment, and, as is well known, even to structures in unstable equilibrium, it is possible that we are on the eve of even more radical changes in design. Ships may now be designed that are practically free from those ballistic qualities which favor rolling structures to which unequal sea pressures easily impart motion need no longer be employed, as a comparatively small gyroscope which can easily be present in duplicate may very readily hold them practically free from rolling motions in such a way that ordinary seas will have little or no effect upon them, while an exceptional wave will have only a temporary effect. It has been suggested in connection with such vessels that they need not pitch if of sufficient length; be this latter fact as it may, it is apparent that a point has now been reached and a situation created with reference to the resisting and prevention of rolling and motion of ships at sea, to say the least, is interesting in many quarters. I heartily commend this subject to those who are interested in providing safety and comfort to passengers at sea, and as also preventing deterioration of certain classes of freight; for instance, live stock is known to suffer heavy depreciation in

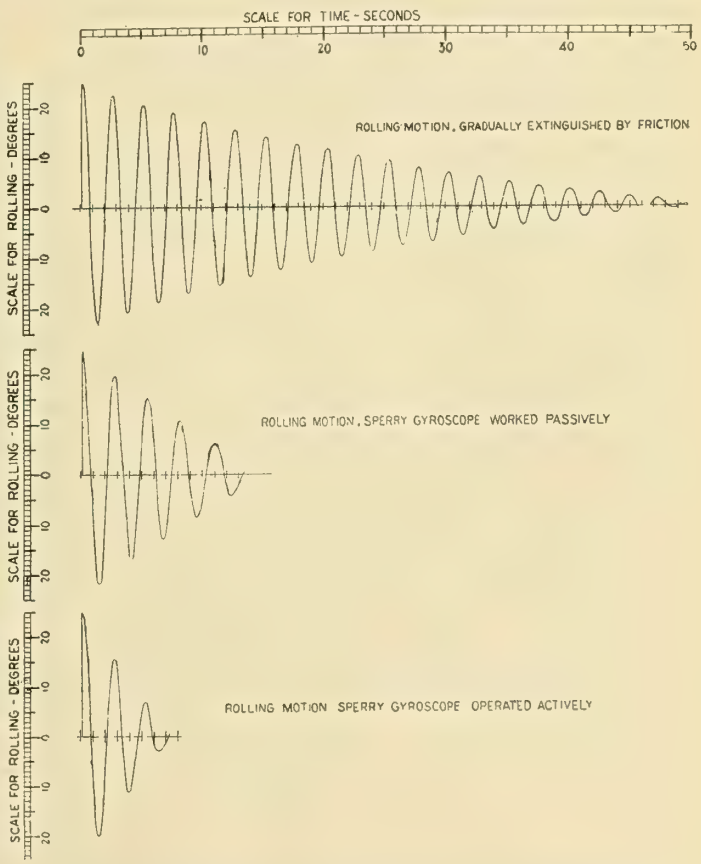


FIG. 5.—DIAGRAMS SHOWING RELATIVE EFFECT OF ACTIVE AND PASSIVE GYROSCOPES.

stormy weather. This is entirely outside naval uses, especially as related to gunnery, trimming ships to secure level gun platform, suppression of recoil from broadside firing, and other uses.

It is evident from what we know that the early workers were hampered by too close adherence to the earlier treatment of statical stability, and the direct effect of wave slope, together with some other elementary factors, rather than the more practical considerations of the effect of movements of the ship, stresses involved, etc.

In 1904 Dr. Schlick presented a paper before the Institution of Naval Architects. Accompanying this paper in the form of an appendix is a mathematical treatise of the theory of the gyroscope and its application to steadying ships. There seems, however, to be little in this treatise which we find useful in the practical application of the gyroscope, especially the active type of gyroscope to ships. The eminent authority, Capt. Taylor, in his report on this subject states of this treatise that it is a very elaborate mathematical theory, but that it largely ignores practical considerations.

The problem is a comparatively simple one, namely, of holding the ship against rolling by neutralizing with the gyroscope each disturbing influence as it reaches the ship while availing ourselves of all the aid possible through the design of the hull and disposition of the masses. With this end in view we do not yet know the best relation between these two factors. With the last adjusted to best fit the new conditions it is believed that the gyro-steadying plant of the active type will be well within practical limits of space, weight and cost. Especially is this true when compared with the practical results of its operation. A great many ships as they now stand could, with profit, utilize the gyro-steadying gear of this class, which is at present available, and some important installations are now being contemplated. In this connection it is interesting to note that the weight of an active gyroscope for each degree of roll-quenching power on a modern battleship would be about one-tenth that of the submerged armor displaced, and cost much less, this being outside of the very important consideration of having the entire ship under control, either automatically to extinguish roll or at the will of the commander, with its many evident advantages.

Referring to the use of the gyroscope as a compass, it is interesting to note that the possibility was first brought out in 1852 by Foucoult, who, after many attempts, succeeded finally in making up an apparatus so delicate and beautifully constructed as to demonstrate the working of the instrument in the short period of duration of spins of a small disc, the observations being taken through a telescope, the directive factor being only a fraction of that of the magnetic needle, with this difference, however, that magnetism or the location and variations in the positions of the magnetic meridian have nothing whatever to do with its directive feature, and, in fact, it points to exact geographical north, not to magnetic north.

About this time Foucoult took this apparatus to England, and there aroused the greatest enthusiasm in scientific circles by exhibiting it in operation to the Royal Society. Hopkins in America, associated with the *Scientific American*, in 1878 made a small electric-driven gyroscope by means of which better and more persistent results were obtained. More recently, attempts have been made by a German firm to use mercury floats for sustaining the rotating wheel constituting a gyrostat, which, in this instance, runs at the enormous speed of between 22,000 and 23,000 revolutions per minute, which has been considered by many to be impractical. Those familiar with the use of mercury in its mechanical and also electrical applications usually find it very unsatisfactory. At best it is a volatile liquid, subject to many changes with differences in temperature, and, which is worse, is also subject to the phenomenon known as "sickening," which affects the surface and the mercury, and for some distance under the surface, altering its mechanical behavior and also its viscosity. The best engineering practice has for some years avoided the use of mercury, drawing away from its use in every possible way, and especially where electrical connections were involved, and substituted, in their stead, simple mechanical methods which are free from these serious objections. Working in this line I have found simple details by means of which the whole gyroscope proposition is reduced to a strictly mechanical basis, easily within the comprehension of all and containing no unknown quantities and correspondingly easily dealt with. In the cases where the gyroscope is employed as a battle compass, the apparatus is placed below decks, and small instruments about the size of an ordinary compass are distributed in different positions on the ship, giving the exact indications of the gyroscopic compass itself.

My work has extended to the point where action of such instruments can be controlled from the gyroscopic compass and distributed as desired, the indications being accurate to a very small fraction of a single degree. Many observations have been made indicating that they are accurate to thirty-six hundredths of an entire circle. The battle compass as it is mounted on an artificial ship gives all changes of heading, as well as automatic continuous roll and pitch to which the compass is continually subjected. Both roll and pitch may be varied at will as to angle and period.

Among the points never before realized is the automatic correction of the northerly or southerly component of vessels' speed at sea, this correction being made between the gyroscopic compass and its transmitting member, in such a manner that the indications received by the navigator and elsewhere about the ship are thus absolute and maintain true geographical north. It is felt that the navigator has now at hand a most desirable aid and one that greatly simplifies his work. It will be understood that this type of compass is not affected in the slightest degree by the steel of the ship or cargo, nor any magnetic disturbances in either; neither should shifting cargo, turning turrets or gun-fire disturb its accuracy or reliability, nor is it affected in the slightest by those disturbances technically known as deviation or variation.

Rulings of the Office of the Supervising Inspector-General of the United States Steamboat Inspection Service.

The Taylor Water Tube Boiler Company of Detroit, Mich., in a letter dated November 2, 1910, called the attention of this Bureau to an evident contradiction in Section 20, Rule II, General Rules and Regulations, which section reads in part as follows:

"Hard brass, bronze * * * may be used in the construction of all fittings up to and including 12 inches in diameter, and for all pressures not exceeding 300 pounds per square inch, except that it will not be allowed where the steam reaches a temperature of 400 degrees F. * * *, and stated that:

"Inasmuch as the temperature of saturated steam at 235 pounds is 400 degrees, this paragraph seems to carry a contradiction, and we would therefore ask if it would be permissible for us to use brass or bronze globe valves and unions up to 2 inches in size for these boilers."

This Bureau, in a letter dated the 5th instant, replied in part as follows: "Your statement that saturated steam at 235 pounds pressure has a temperature of 400 degrees Fahrenheit is practically correct * * *."

"As the object of the rule was to limit the use of these fittings to a temperature of 400 degrees Fahrenheit, you are informed that you cannot use the fittings in question for steam

pressures of more than 235 pounds, and the service generally will be advised of this decision."

With reference to that part of Section 20, Rule II, General Rules and Regulations, under the head of Cast Steel, Semi-steel, etc., which reads:

"Screwed bonnets on cast iron valves are positively prohibited," the Supervising Inspector General, in a letter dated November 7, 1910, advised that "the rule is plain and means just what it says, and there is no distinction whatever in the use of a valve on a water line or steam line. The rule *prohibits* the use of a cast iron valve with a screwed bonnet, and if such a valve is found in use it must be removed at once."

With reference to Section 28, Rule II, General Rules and Regulations, which reads:

"On all boilers built after July 1, 1896, a stop cock or valve shall be placed between all check valves and boiler and between all steam and water pipes and the boiler.

"All boiler connections of over 2 inches in diameter, except the connections for safety valves, shall be permanently flanged and bolted directly to the boiler. Where the connecting point on the boiler is of circular form, distance pieces shall be allowed in order to square the point of attachment of the flanged fittings, but no such distance piece shall be allowed to exceed 6 inches in length on its shortest side," the local inspectors at Detroit, Mich., in a letter dated November 4, 1910, stated:

"We enclose herewith a blue print showing one method of attaching the auxiliary stop valve, which shows a cast steel distance piece about 3 inches in length on its shortest side, riveted to the boiler; to this distance piece is bolted a cast iron tee about 12 inches high, the safety valve being bolted to the top opening of this tee, and on the side of this tee is bolted the auxiliary stop valve leading to the small engines throughout the ship.

This method of attachment is used for the purpose of using one opening in the boiler for both the safety valve and the auxiliary steam valve, and we ask if such method of attachment can be allowed, or whether the auxiliary stop must be attached to the boiler at a separate opening, properly reinforced and with the required distance piece."

This office, in reply thereto, in a letter dated November 7, 1910, stated that:

"This appears to be good practice, and in my opinion is not prohibited by the rule which you quote and which governs this question. If this 4-inch valve were really a *boiler* connection it would have to be bolted directly to the boiler, and would not be allowed to meet a nipple or other fitting, except that if fitted to a circle it would be allowed to meet a distance piece as provided by the rule.

It is *not* attached directly to the boiler, and hence it can meet the fitting as you describe it and which I think makes a good job. I would much rather see this tee made of cast steel, but inasmuch as we allow cast iron for fittings when properly stamped and made in accordance with the prescribed formula, we have no authority to require anything better."

Referring to the last paragraph of Section 28, Rule II, General Rules and Regulations, which reads:

"All boiler connections of over 2 inches in diameter, except the connections for safety valves, shall be permanently flanged and bolted directly to the boiler. Where the connecting point on the boiler is of circular form, distance pieces shall be allowed, in order to square the point of attachment of the flanged fittings but no such distance piece shall be allowed to exceed 6 inches in length on its shortest side," the Supervising Inspector General, in a letter dated November 7, 1910, advised the local inspectors at Detroit, Mich., that "The rule in question does not apply to safety valve connections."

TEST OF A MOSHER MARINE BOILER.

By an order issued by the Navy Department, Washington, a board of naval officers, made up of Commander C. W. Dyson, Lieutenant-Commander J. K. Robison and Lieutenant W. G. Diman, met at the works of the Mosher Boiler Company, Ossining, N. Y., to witness the evaporation tests of one of the boilers built under contract for the United States ships *Kearsarge* and *Kentucky*.

The object of the test was to ascertain whether the boiler was capable of evaporating an amount of water into dry steam equivalent to 11 pounds from and at 212 degrees F., per hour, per pound of combustible, when burning coal at the rate of 40 pounds per square foot of grate. Also to ascertain the evaporation from and at 212 degrees F. per pound of combustible at rates of combustion of 15, 25 and 35 pounds per square foot of grate, respectively.

The tests started at 8 A. M. Nov. 1, and continued without interruption until 8 A. M. Nov. 5, when they were completed, each of the four tests thus occupying twenty-four hours.

DESCRIPTION OF THE BOILER.

The boiler in question is known as type B in contradistinction to type A, which is used in the torpedo boat destroyers *Lamson* and *Smith*, as well as various other vessels. It consists of one large steam drum connected by means of curved tubes to a semi-circular water drum having an arched tube sheet. Two large diameter down-comers, one at each end of the steam drum, connect to a return tube on each side and form a junction at the rear end to the water drum, thereby constituting a self-contained unit. The boiler rests on steel saddles, casing and grate-bar bearers being built up and connecting to it. The boiler furnace, from the grate-bars to the tubes and drums, is lined with special firebrick. The baffling of the gases is accomplished in a manner quite similar to that adopted in the Babcock & Wilcox marine boiler, thus forming a first, second and third tube pass within which the gases traverse before the up-take is reached. Unlike the boiler mentioned, however, the gases in the Mosher boiler enter the tube nest near the steam drum and leave at the opposite or water drum end. This arrangement insures a positive circulation of water and steam within the tubes at practically any rate of combustion, but invites a possible short circuiting of air entering the furnace, which, if so, would result in impaired combustion of the gases within the tube nest. The boiler tested was full size, being one out of the lot intended for installation in the *Kearsarge* and *Kentucky*, and had the following dimensions:

Heating surface	3,980 square feet.
Grate surface	91.25 square feet.
H. S. ÷ *G. S.*	43.6
Diameter steam drum	48 inches.
Water space	222 cubic feet.
Steam space	101 cubic feet.
Number of generating tubes	883
Diameter of generating tubes	2 ins. No. 8 B.W.G.
Average length of generating tubes	8 feet 5½ inches.
Total weight of boiler, inclusive of water	91,551 pounds.
Weight per square foot *G. S.*	1,003 pounds.
Weight per square foot *H. S.*	23 pounds.
Steam pressure	180 pounds.

ARRANGEMENT OF TESTING PLANT.

The boiler was erected in a practically air-tight house, furnished with air locks used when the test room was under pressure. There was an overhead platform, from which observations of the weighed water, steam pressure and stack pressure were made. The regulation of the steam pressure

was also performed here by manipulating the stop valve forming the connection between the main steam pipe on the boiler and the bleeder to the atmosphere. Safety valves and calorimeter were also placed above this platform.

Forced draft was produced by a Buffalo Forge Company fan, driven by a belt transmission from a single-cylinder reciprocating engine. The blower was located outside the boiler room, discharging into it diagonally towards the rear of the boiler, whereby continuous ventilation of the fire room was obtained.

The feed-water entered at about the center line of the steam drum, and was heated to a high degree by first passing through a multi-coil Reilly feed heater. Steam from the boiler was used as heating medium in the feed heater, which was fitted with a continuous recording temperature gage.

The feed pump was located just outside the boiler room and close to the circular feed tank, into which was discharged the water weighed in each of the two weighing tanks, placed on platform scales immediately above on the raised platform previously referred to.

Calibrated thermometers were placed, one in the feed line on the discharge side of the heater as close to the boiler as was practicable, the other in the suction pipe from the feed pump to the feed tank.

The fire-room temperature was measured by a thermometer placed in front of the boiler under the boiler grating. A continuous-pressure recording gage was placed on the steam line, and a Taylor Cambridge electric pyrometer was fastened on the wall of the boiler-room, where connection to it was effected by means of metallic rods, which were inserted at different points through the side of the boiler whenever readings were taken. A nitrogen pyrometer was placed in the flue to obtain the temperature of the gases.

An Ellison multiplying draft gage was placed on the opposite side of boiler room, connections being made through the dusting doors of the boiler casing by means of a long pipe attached to rubber tubing. An ordinary U-tube was placed near the smokestack to obtain the draft at this point.

An Orsat gas analysis apparatus was located within the fire-room near the rear end of the boiler, samples of the gases being taken continuously and records made at frequent intervals. As the gas was drawn off continuously, very close average gas conditions were obtained. A Barrus throttling calorimeter was fitted on the steam pipe between the boiler and the safety valves, and was in continuous operation during the entire test.

WEIGHING OF COAL AND WATER.

The platform scales for weighing coal were placed outside of fire-room. The coal was placed in barrows arranged to give net weights of 250, 200 and 150 pounds, in order to facilitate tabulation of the weights of the two kinds of coal used, viz.: Pocahontas and Somerset.

The water was taken from the city main and delivered into two cylindrical tanks placed on separate scales and weighed. By means of quick-opening valves it was discharged into the calibrated feed tank placed directly below. The height of the water in this tank was noted at the beginning and end of each test.

MOISTURE IN STEAM AND COAL.

The moisture in the steam was determined from the temperature readings taken at definite time intervals during each test, and the average temperatures obtained by calibration of the calorimeter at the completion of the tests. The moisture in the coal was obtained by laboratory tests made with samples collected at definite times during the tests.

COAL USED AND METHOD OF FIRING.

It was found necessary to use, in connection with the Pocahontas coal obtained purposely for the test, as certain proportion of Somerset coal, in order to more readily break up the clinkers which spread over the grate, partly stopping up the air spaces when using Pocahontas alone. The slag formed by the Pocahontas coal seemed to accumulate about the ash of the Somerset in such a way as to enable dislodging by slicing the clinkers without too much trouble.

The method of firing adopted was the so-called alternate system, consisting of spreading the coal evenly over the grates, with regular time intervals between each firing and a certain number of shovelsful fired at each door. These varied between two to six, depending upon the rate of combustion. The thickness of the fires varied from 4 to 6 inches at the front and between 6 and 10 inches at the rear.

The ashpan was hauled at the end of one test and the beginning of the next; the amount was weighed and corrections made for moisture.

The proportions of coal used were as follows: First test, 2 Pocahontas to 1 Somerset; second test, 5 Pocahontas to 2 Somerset; third test, 5 Pocahontas to 1½ Somerset; fourth test, same as third, except that for the last four hours Pocahontas coal was used exclusively.

RESULTS.

Test No. 1, at 15 pounds coal per square foot of grate per hour, began 8 A. M. Nov. 1, and finished at 8 A. M. Nov. 2. Weather clear; the compartment was open. The rate of evaporation from and at 212 degrees F. per pound of combustible was 12.09 pounds of water into dry steam.

Test No. 2, at 25 pounds coal per square foot of grate, began 8 A. M. Nov. 2, and finished at 8 A. M. Nov. 3. Weather clear at beginning, then cloudy and rainy; the compartment was closed, with an average air pressure of 1.04 inches of water. The rate of evaporation, figured on same basis as test No. 1, was 11.58 pounds of water into dry steam.

Test No. 3, at 35 pounds coal per square foot of grate, began at 8 A. M. Nov. 3, and finished at 8 A. M. Nov. 4. Weather, rainy; compartment was closed with an average air pressure of 1.65 inches of water. The rate of evaporation, figured same as before, was 10.85 pounds of water into dry steam.

Test No. 4, at 40 pounds coal per square foot of grate, began at 8 A. M. Nov. 4, and finished at 8 A. M. Nov. 5. Weather rainy during first half, then clear. The compartment was closed; fan in operation, with an average air pressure in the fire-room of 1.62 inches of water. The rate of evaporation, figured same as before, was 11.048 pounds of water into dry steam. The actual amount of coal burnt per square of grate was 39.91 pounds.

Difference between pressure in fire-room and draft in flue for the four tests was 0.23, 0.64, 1.58 and 1.8 inches, respectively.

Average moisture in coal used for the four tests was 3.31, 2.23, 3.31 and 3.06 percent, respectively.

The average percent of refuse in dry coal was 8.54, 7.15, 5.68 and 5.84, respectively.

The proximate analysis of the fuel used gave:

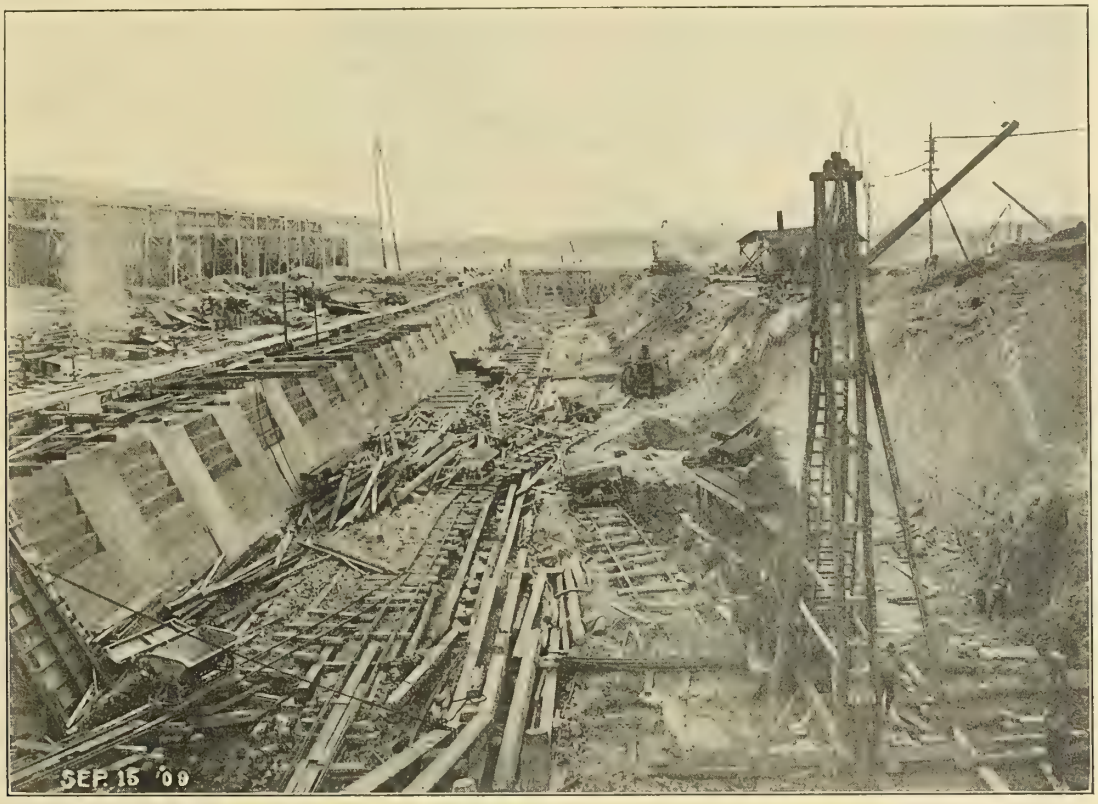
	Somerset. Percent.	Pocahontas. Percent.
Fixed carbon	71.53	75.68
Volatile matter	14.91	19.67
Moisture	4.57	2.34
Ash	8.99	2.30
Sulphur	1.60	.72

Calorific value of coal by calorimeter per pound of combustible: Somerset = 15,968 British thermal units, Pocahantas = 15,464 British thermal units.

After completion of the tests the boiler was opened up and examined and found in good condition.

NEW DRY-DOCK OF THE TOLEDO SHIPBUILDING COMPANY.

A large dry-dock, involving some unique features of construction, has recently been built at the yards of the Toledo Shipbuilding Company, Toledo, Ohio. The dock is 100 feet by 700 feet, and is designed to accommodate the largest vessels operating on the Great Lakes. It is built throughout of concrete, and there is in conjunction with it a building berth located on one side of the dock, so that vessels can be side-launched directly into the dock. This is the first time that such an arrangement has been carried out, and its advantages, of course, are obvious. The building berth, with its gantry crane, the dock walls and portals are built entirely of steel and concrete. The only timber used is in the pile foundations, the floor system and the temporary end of the dock, which is designed to be lengthened should it ever become necessary to provide for ships longer than the 600-foot class.



VIEW OF NEW TOLEDO DRY-DOCK UNDER CONSTRUCTION.

This new dock is built on the site of an old wooden dock, which was 50 feet by 150 feet. The entrance is irregular in outline, because the dock and harbor line are not at right angles. Its dimensions are 114 feet 7 inches along the harbor line, 37 feet across the west end, 30 feet across the east end, and it has a depth of 27 feet. The clear portal entrance dimensions are 94 feet and 82 feet across the top, and still levels respectively with a depth of 21 feet 6 inches. These dimensions will admit any boat now in use on the Lakes, or which is likely to be constructed for some time to come.

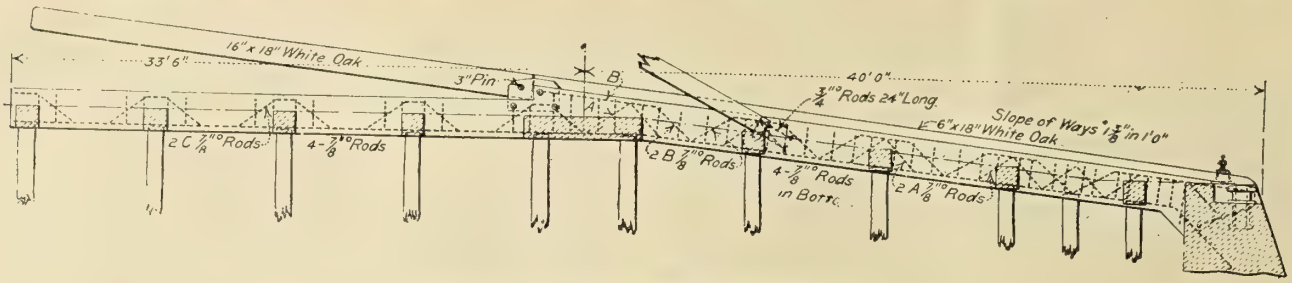
The photographs and drawings show the nature of construction and the general arrangement of the dock relative to some of the shops in the yard. A complete description of the dock appeared in a recent issue of the *Engineering Record,* from which the following is taken: The dimensions of the dock proper are 78 feet width along the floor sill line, 95 feet width face to face of dock walls at mean water level, and 659 feet length from the dock side of the portal to the end along the center line. The floor of the dock has a pitch of 6 inches from either side to the center drain, and a drop of 3 feet 3 inches in the total length. The east dock wall is of uniform section from end to end, with a footing 2 by 14 feet and wall 14 feet across the base, 3 feet across the top and 25 feet 6 inches high. The top of the west wall, which is the launching side, is necessarily level, so that the wall section varies in height from 22 feet 6 inches at the portal to 19 feet 3 inches at the far end. The footing is uniformly 2 feet by 14 feet and the top 4 feet 2 inches. The walls rest on firm blue clay and 20-foot piling. The piling rows are spaced 5 feet and the piles about 4 feet.

Both walls have sets of four steps at every alternate 10-foot sections for shoring, and have the necessary sheaves for bilge block chains. In addition, the west wall has large cast iron snubbing posts set flush with the wall top and face for 40 feet, and malleable iron pedestals every 10 feet for supports to the 9-inch channel stringers carrying an A-frame track.

The timber floor is carried on the clay and on piling. White oak 12-inch by 12-inch caps run lengthwise of the dock, and every 10 feet 6 inches carry 14-inch by 14-inch yellow pine sills level from wall to wall. Short 14-inch by 14-inch white oak sills carry intermediate sets of keel blocks. The long sills carry 3-inch by 18-inch white oak slides, and on these the bilge blocks have their bearing. The 2-inch overhang of the 18-inch planks serves as a grip for the bilge block anchors. The bilge and keel blocks are built up with 12-inch by 12-inch and 14-inch by 14-inch timbers drifted together. The 3-inch oak plank flooring is laid between the sills, having a pitch of 6 inches toward the center to facilitate drainage.

The end of the dock is constructed of timber, in order to simplify the matter of lengthening if such action should be deemed necessary in the future.

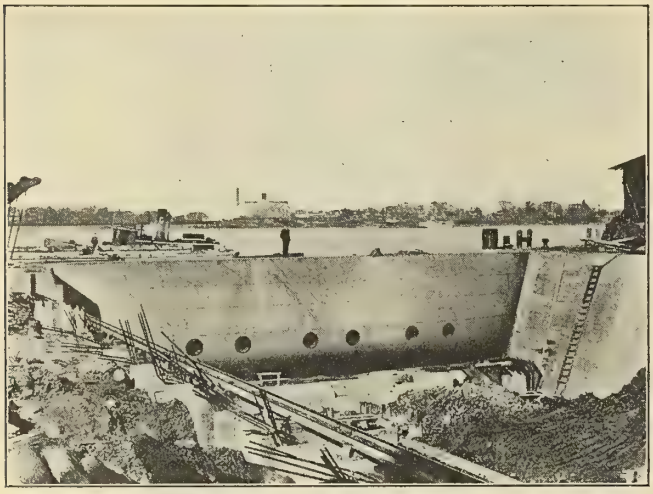
The building berth has introduced an entirely new feature in dock construction, in that it is entirely of reinforced concrete. It has a width of 79 feet; the full length of the dock. Concrete ways are located every 10 feet and concrete cross-tie beams every 7 feet 6 inches, the whole supported by 30-foot



DETAILS OF REINFORCED CONCRETE BUILDING WAYS.

pile foundation. The ways have a section of 24 inches by 27 inches, reinforced with six and eight 7/8-inch plain bars and 7/16-inch stirrups.

The ways have a rise of 3 feet in the 40 feet next to the dock, and in this part heavier reinforcement is placed to take care of the launching strain due to the motion of the sliding boat. The concrete cross-tie beams have reinforcement of eight 9/16-inch plain bars and 7/8-inch stirrups. Trigger lugs



GATE OF NEW DRY-DOCK.

are cast on the ways on the side away from the horizontal center line of the berth. An 11-foot 3-inch by 3-foot 5-inch by 10-foot concrete rudder well is provided near the south end of the berth.

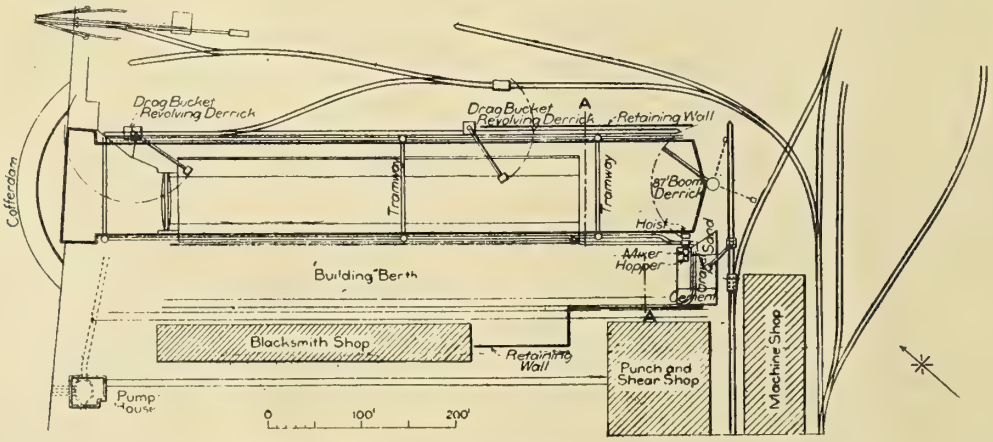
It was necessary to construct a cofferdam and in connection with the excavation to remove the old wooden dock. The tearing out of the old dock timbers was started on March 15, 1909, and the new dock was made ready for a boat Dec. 18, 1909. The general layout and design were prepared by Mr. A. V. Powell, M. Am. Soc. C. E., of Chicago. The design of the steel work, reinforced concrete ways and gate was worked out at the shipbuilding company's engineering department under the direction of Mr. C. B. Calder, general manager. Mr. Harry C. McClure acted as inspector for the company. The work was executed by the A. Bentley & Sons Company, of Toledo, Mr. C. O. Lasley, Assoc. M. Am. Soc. C. E., being engineer.

TWIN-SCREW MOTOR YACHT JOYEUSE.

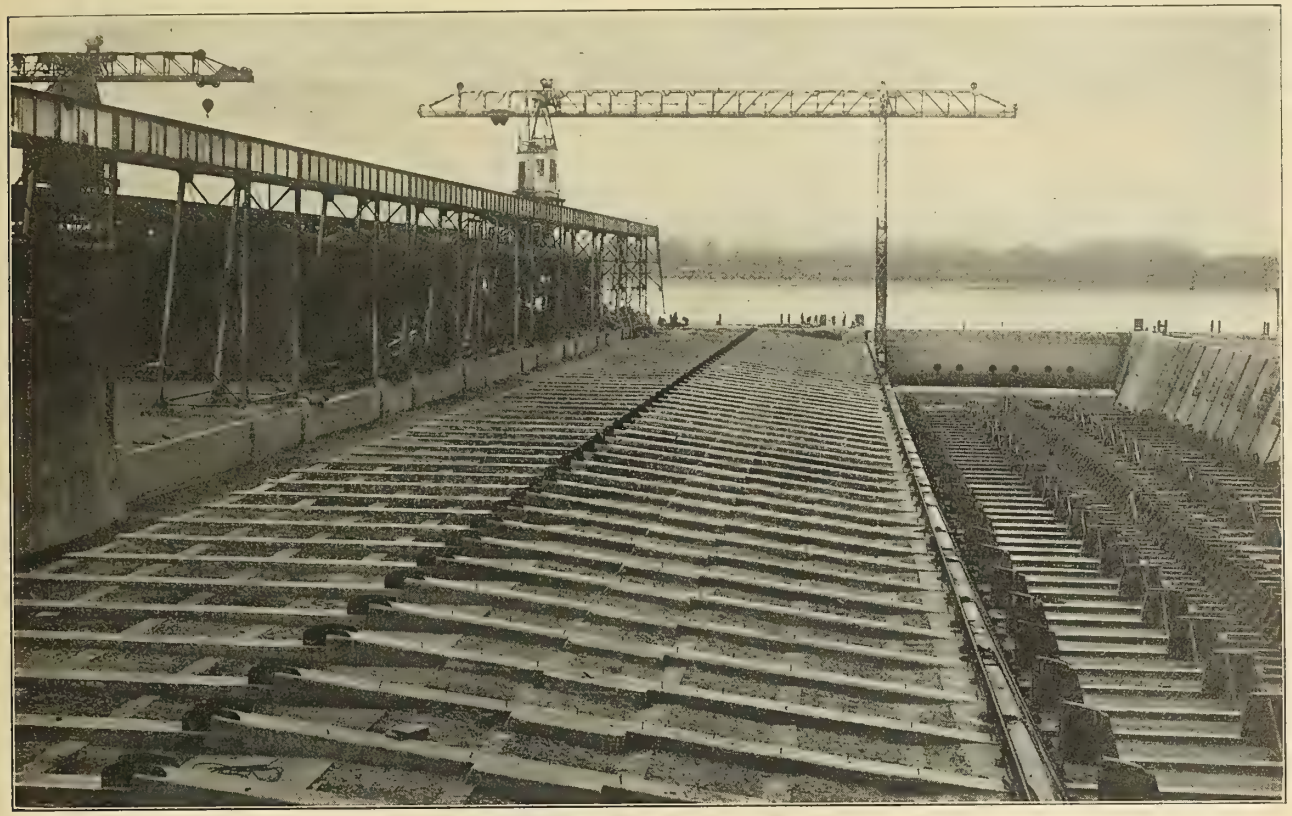
One of the most successful boats designed for use as a gentleman's yacht during the past season is the twin-screw craft *Joyeuse*, designed by Messrs. Cox & Stevens, of New York, and built by the Pusey & Jones Company, of Wilmington, Del., for Mr. Henry W. Savage, of New York. The principal dimensions are: Length over all, 98 feet; beam, 16 feet; draft, 4 feet 6 inches.

The motor power consists of two six-cylinder, air-starting Standard engines, with a nominal horsepower of 100, but which develop better than 125 horsepower apiece, and give a speed of at least 15 miles an hour. The engines are situated amidships, and are in a compartment separated from the rest of the vessel by heavy steel watertight bulkheads, without any openings in them whatsoever; this compartment also contains the gasoline supply, which is of 1,500 gallons, carried in three copper tanks of 500 gallons each. The engine compartment contains in addition an electric light plant of sufficient capacity to light the boat throughout, including a large searchlight.

The general appearance of the boat is pleasing, her freeboard being moderately high, and the vessel being of flush-deck type, with bulwarks which tend to reduce the apparent height of the deckhouses, of which there are two. The forward house is used as a music room, and the after-house is the dining room; this arrangement being decided upon for the reason that the owner's quarters are forward and the crew aft. Two pole masts are carried, on which sail can be spread when



PLAN OF TOLEDO DRY-DOCK, SHOWING CONTRACTOR'S EQUIPMENT IN PLACE.

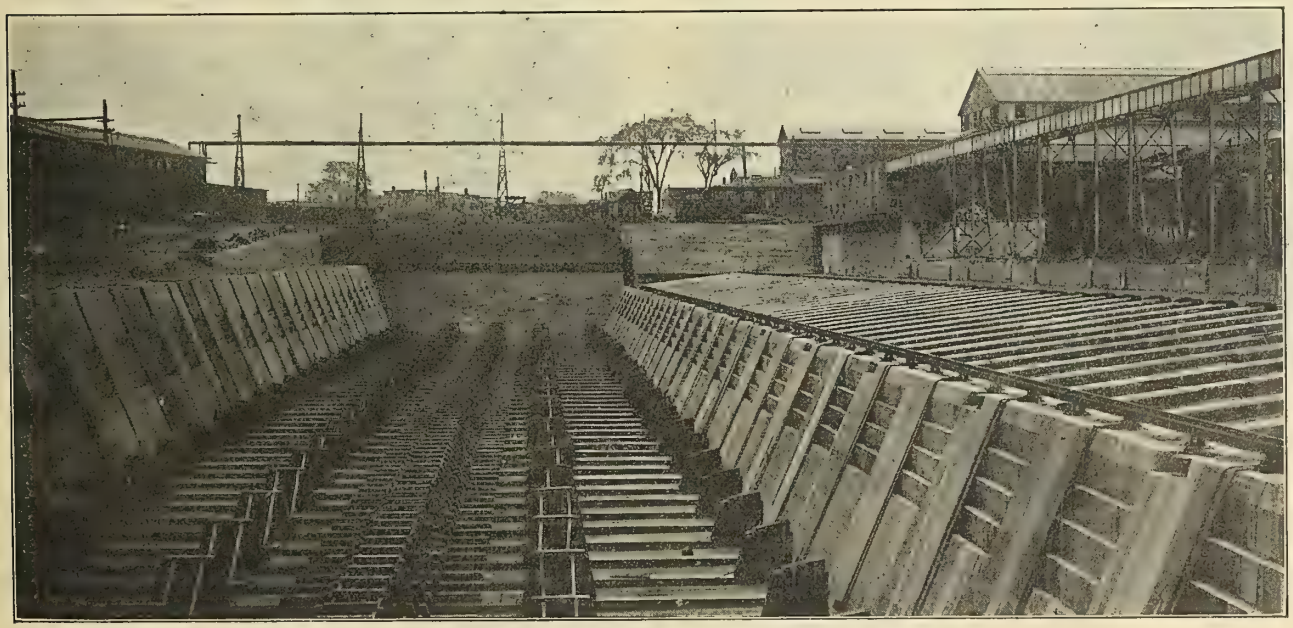


VIEW OF COMPLETED DRY-DOCK AND REINFORCED CONCRETE BUILDING BERTH, WITH GANTRY CRANE.

desired, these masts and the stack being so arranged that they can be taken down in passing under canal bridges.

The construction of the hull of the vessel is of steel, sufficiently strong to make the boat a durable one, and not so heavy as to overload her; this form of construction being adopted for the reason that it gives much more available space below for quarters than as if the vessel were built of wood. In addition to the steel bulkheads enclosing the engine room, there is a forward and also an aft collision bulkhead, so that the hull is well sub-divided for protection against collision.

The deck houses and all the skylights, hatches, hand rails, etc., are of mahogany, the deck itself being of white pine, all the deck fittings being of bronze, and all appointments of every description being of the best possible character. The owner's room is just forward of the engine space, and separated from it by a double bulkhead to reduce the noise from the engines. This room extends the full width of the vessel, and is 10 feet in length. In finish this room is of satinwood, handsomely paneled, and furnishings consist of a large double berth on the port side, with a wardrobe forward of same, and on the starboard side a writing desk, bureau and seat, which



INTERIOR OF THE DOCK, SHOWING KEEL AND BILGE BLOCKS IN PLACE.

may also be used for stowage space. On the after end of this room, on the starboard side, a 7-foot sofa is placed against the bulkhead, and on the port side, completely shut off from the stateroom, is a lavatory; this portion of the room being so arranged by an ingenious layout of pillars and columns so as to make a very attractive appearance and at the same time give the owner a great deal of comfort.

On the starboard side of the passage the space underneath the stairs is utilized as a storeroom, having in it a berth that in an emergency can be used for a valet. On the port side of the passage, opposite the stairs, is a large bathroom, having a 5-foot 6-inch tub, wash basin, toilet and linen locker; this room being tiled floor and having a wainscoting tiling also. Forward of the bathroom on the port side is a single stateroom, with a built-in berth, bureau and seat, a similar stateroom being opposite this room on the starboard side. At the end of the passage and opening into it, the space forward of the two single rooms just mentioned is utilized as a large stateroom, having on the port side a double built-in berth and bureau, and on the starboard side a wash basin, wardrobe and settee. All these rooms are finished in Colonial style, with mahogany furniture, doors and trim, the balance being white enamel finish with egg-shell gloss, handsomely paneled.

The forward house, to which reference has already been made, has at its forward end a stairway on the starboard side leading to the quarters below, and on the port side upholstered transoms, which can be used as berths in an emergency, and otherwise form comfortable seats. In the after end of this house is a piano and writing desk. This house is of very liberal dimensions, being 9½ feet wide and 16 feet long, and forms a very comfortable lounging space. The finish inside and out is of carefully selected mahogany, handsomely paneled, and the color scheme of the upholstery is green, making a very pleasing combination.

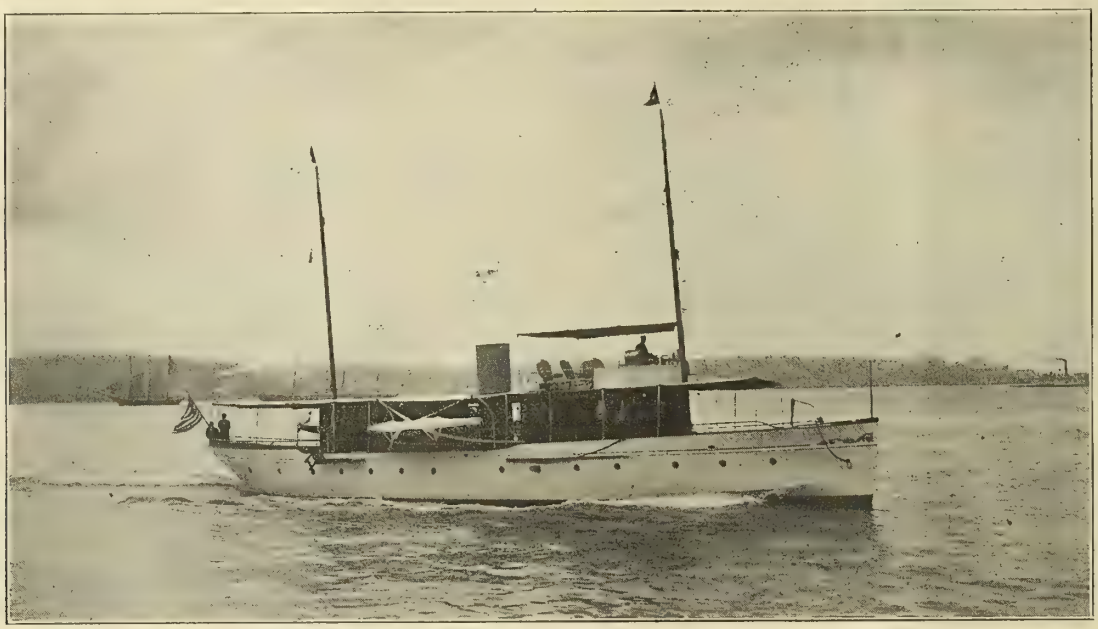


FIG. 1.—MOTOR YACHT JOYEUSE, DESIGNED FOR HENRY W. SAVAGE BY COX & STEVENS.

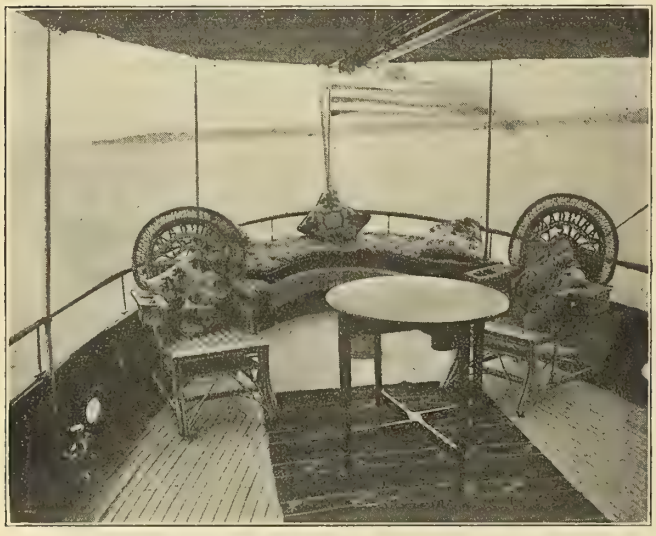


FIG. 2.—AFTER DECK.

FIG. 3.—SMOKING ROOM, LOOKING FORWARD.

PLAQUE PRESENTED TO REAR ADMIRAL MELVILLE ON HIS SEVENTIETH BIRTHDAY.

The after-house is the same breadth as the forward house, and is 16 feet in length. The forward part of this house is utilized for a pantry, and contains an ice-box, dish rack, sink, glass cupboard, dumbwaiter to the galley, which is below, and has on the port side a recess, partitioned off, forming the entrance to the engine-room. The pantry is finished in mahogany, and the floor tiled with interlocking rubber tiling. This room communicates by swinging doors to the dining-room, which is in the after portion of the house. The only fixed furniture in the dining-room is a very handsome Colonial sideboard in the forward end, there being a round extension table, capable of accommodating twelve persons when fully opened, and the necessary number of mahogany dining chairs.

On deck there is ample room for the owner and his guests, the deck being exceptionally clear and free from obstructions. The vessel is navigated from on top of the forward house, there being an awning over this house, so that it makes a very comfortable place for the owner and his guests as well as for the helmsman. This vessel is also very fully equipped in each department, the outfit of boats including a 16-foot motor boat, with a speed of 8 miles an hour, and also a 14-foot dinghy or service boat.

The yacht has attracted wide interest on account of her variation from the conventional design of yachts, and while Messrs. Cox & Stevens have turned out a boat that is entirely unique, many of the little details and conveniences show careful thought on the part of Mr. Savage, who is not only an ardent yachtsman but a sailor of long experience.

The unusual flexibility and reliable performance of the boat's engines on her maiden trip from Wilmington to New York, through the canal, is a matter of comment. The ease with which she handled in and out of canal locks, at times when absolute stopping and starting of the engines was necessary, was a source of great satisfaction. Later on, in deep waters, during a period of very heavy weather, her performance was equal to that of boats twice her size—the full, flaring bow keeping her practically dry through the worst of it, and her roll being remarkably easy.

The first steamboat ever built in Venezuela was launched November 6, 1910. The vessel is of 61 tons displacement.

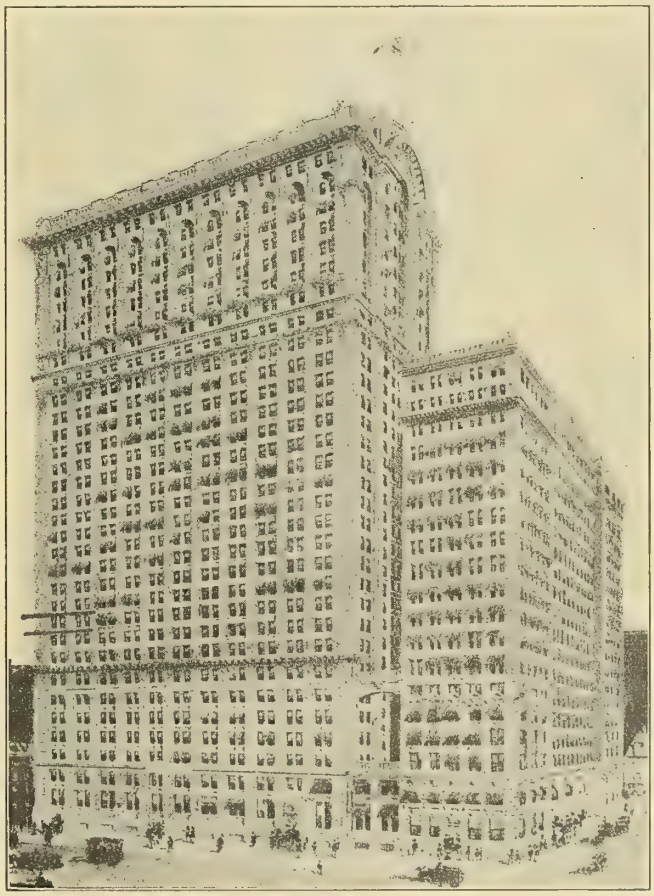
Tribute to Rear Admiral Melville.

Tuesday, the 10th of January, being the seventieth birthday of Rear Admiral George W. Melville, engineer-in-chief of the United States navy, retired, a few of his friends, with very little preliminary notice, recognized the occasion by presenting him an engraved plaque. At the top was a picture of the *Columbia,* at the bottom a picture of the Melville reducing gear, and at the sides badges of the Grand Army of the Republic and the Loyal Legion. The photograph shown herewith gives a very excellent idea of the appearance of the plaque. Accompanying this was an engraved address of congratulations with the names of the ninety-six contributors.

Rear Admiral Melville was for sixteen years engineer-in-chief of the United States navy. During this time he was responsble for new designs of machinery for about one hundred and twenty vessels of all classes, including twenty-four battleships and forty-one armored vessels of all kinds. The aggregate horsepower was close to a million and a quarter. One of the most notable triumphs of his professional career was the use of triple screws on the cruisers *Columbia* and *Minneapolis,* while to-day his development of reduction gearing for marine steam turbines bids fair to solve one of the most important engineering problems of the day.

New Offices for International Marine Engineering.

The increased demands put upon us for office facilities have necessitated our moving into much more spacious quarters, and, beginning Feb. 1, our offices in the "Whitehall Building," 17 Battery Place, New York, will be in the recently-completed addition to the building in rooms 934 and 935. We shall have considerably more floor area and better facilities in



THE NEW WHITEHALL BUILDING, WHERE "INTERNATIONAL MARINE ENGINEERING" IS PUBLISHED.

every way for expediting business. On the picture shown herewith the four office windows facing the west have been marked to locate the new offices. The rooms extend back across the greater part of the north end of the building. As we command a view of New York harbor, the Statue of Liberty, and all of the shipping passing in and out, we invite our friends to call and not only inspect our spacious new offices but also enjoy the view from our windows.

SHIPBUILDING IN 1910.

According to figures published in the Glasgow *Herald,* the total tonnage of vessels, including warships, built in the world in 1910 was 3.6 percent greater than that built in 1909. In the United Kingdom there was an increase of 13.4 percent; in the United States an increase of 25 percent, and in Japan an increase of 11.1 percent. Most of the other important shipbuilding countries suffered a marked decline. In Germany the total tonnage, including warships, built in 1910 was 21 percent less than that built in 1909. In France there was a decrease of 17 percent; in Italy a decrease of 9.8 percent; in Russia a decrease of 16 percent; in Belgium a decrease of 12.2 percent, and in Holland a decrease of 29 percent. The figures are as follows:

	1910.		1909.		Increased Tonnage Built Percent.
	Tons.	I. H. P.	Tons.	I. H. P.	
Scotland	420,250	624,268	427,325	638,310	—1.6
England	752,136	861,031	633,299	708,383	18.8
Ireland	167,102	137,730	120,904	123,750	38.2
U. K. totals	1,339,488	1,623,029	1,181,528	1,470,443	13.4
Colonial	24,077	9,237	17,425	6,419	38.1
United States	351,369	304,689	281,271	213,770	25.0
Germany	217,748	303,937	277,155	414,647	—21.0
Holland	124,115	86,919	174,920	72,901	—29.0
France	110,276	170,010	132,877	186,860	—17.0
Japan	60,192	96,638	54,154	52,204	11.1
Italy	36,075	62,600	40,030	62,719	—9.8
Norway	32,998	30,890	32,216	22,533	2.4
Austria-Hungary	32,121	29,796	55,196	70,650	—41.8
Belgium	15,302	26,965	17,429	1,305	—12.2
Denmark	11,922	10,758	11,952	10,306	—0.2
Sweden	9,733	21,940	7,095	23,400	37.2
Other countries	10,319	3,545	10,274	8,595	0.4
Grand total	2,375,735	2,780,953	2,293,522	2,616,752	3.6

A comparison of the work done in the principal shipbuilding centers of the world is shown by the following:

	Vessels.	Tons.	I. H. P.
The Clyde	358	392,392	593,840
United States	151	351,369	304,689
The Tyne	81	236,688	272,991
Germany	310	217,748	303,937
Tees and Hartlepools	86	187,305	115,975
The Wear	58	173,673	124,205

As was the case last year the largest tonnage launched by any one concern during the year was by Harland & Wolff, at Belfast. The leading shipbuilders in the order of tonnage launched during the year are given below:

	Vessels.	Tons.
Harland & Wolff	8	115,861
American Shipbuilding Co. (7 yards)	17	79,598
Russell and Company	12	66,462
Swan, Hunter and Wigham Richardson	16	65,326
The Great Lakes Works	9	58,908
William Gray and Company	13	51,917

The most important launch of the year was that of the White Star liner *Olympic* at Belfast, as described in our December issue. This vessel, it will be recalled, was of 45,000 tons. The next largest vessel launched was the *France,* 23,000 tons, of the Compagnie Generalé Transatlantique, building at the Atlantic Works, St. Nazaire, France. Other large vessels launched during the year included the Cunard *Franconia,* 19,150 tons, by Messrs. Swan, Hunter & Wigham Richardson; the *Edinburg Castle,* 13,326 tons; the *Maloja,* 13,000 tons, and the *Themistocles,* 11,500 tons; all by Messrs. Harland & Wolff.

In the United States, where the most pronounced increase in shipbuilding occurred, the total tonnage of merchant vessels built in 1910 was 332,719. This, as compared with the 207,309 gross tons built in 1909, is an increase of 61.3 percent. The most significant fact connected with this satisfactory increase was the large amount of merchant tonnage built on the Atlantic coast. The gross tonnage of steel steamships built on the Atlantic and Gulf coasts (108,436 tons) was 102 percent greater than in 1909. Only twice in the last ten years have these figures been exceeded—once in 1902 and again in 1907. Both of these years, however, were years of exceptional prosperity in the shipbuilding industry. On the Great Lakes the increase in the gross tonnage of steel steamships during the last year as compared with 1909 amounted to 70.7 percent.

A large number of vessels of 6,000 and 7,000 tons gross were built by the American Shipbuilding Company, as well as many freighters of 3,000 and 4,000 tons. On the coast the greatest volume of merchant work was done at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. The output of this company included four ships of over 6,000 tons each for the Southern Pacific Company; two passenger and freight steamers of 5,425 tons for the Ocean Steamship Company; two freighters of 4,100 tons for the San Francisco & Portland Steamship Company, two Isherwood framed freighters for the A. H. Bull Company, New York, and the oil carrier *J. A. Chanslor* of 4,938 tons. Three steamships of over 6,000 tons were built by the Maryland Steel Company, at Sparrows Point, Md., for the American-Hawaiian Steamship Company. This company also delivered two modern bay steamers. The New York Shipbuilding Company, of Camden, N. J., built two colliers of over 4,000 tons each for the coastwise Transportation Company, Boston, and the principal merchant work at the Fore River Shipbuilding Company, Quincy, Mass., included a 3,800-ton freighter for the Union Sulphur Company, New York, and a molasses steamer of 4,711 gross tons, for the Cuba Distilling Company, besides the magnificent steam yacht *Aloha,* built for Commodore James, of the New York Yacht Club. Two new Wilson Line steamers were built by the Harlan & Hollingsworth Company, Wilmington, Del., and this company also turned out the steamer *Northland,* 3,282 tons, for the Maine Steamship Company. A large part of the work done by coastwise shipyards, however, exclusive of warship construction, consisted of smaller craft, such as tugs, car floats, ferryboats, river steamers, yachts, trawlers, etc.

During the year the battleship *Delaware* was completed by the Newport News Shipbuilding Company, and the *North Dakota* by the Fore River Shipbuilding Company. Eight destroyers were also completed, one by William Cramp & Sons, one by the New York Shipbuilding Company, two by the Bath Iron Works, two by the Newport News Shipbuilding & Dry Dock Company, and two by the Fore River Shipbuilding Company. The Fore River Shipbuilding Company also delivered two submarines. The warships now under construction in the United States include four first class battleships with another one soon to be laid down; nine destroyers with contracts in hand for six more, and nine submarines with three others contracted for but not yet laid down. In addition to this there are 27,000-ton battleships building for the Argentine government at the yards of the Fore River Shipbuilding Company and the New York Shipbuilding Company, as well as a number

of government vessels building at Cramp's for the Cuban navy.

Shipbuilding in the United Kingdom during 1910 was distributed as follows:

	1910.			1909.		
	Vessels.	Tons.	I. H. P.	Vessels.	Tons.	I. H. P.
The Clyde	358	392,392	593,840	354	403,187	610,985
The Forth	17	9,385	5,935	17	9,224	8,100
The Tay	15	5,982	7,800	11	8,074	8,590
Dee and Moray Firth	60	12,491	16,693	36	6,840	10,635
The Tyne	81	236,688	272,991	112	199,307	262,996
Tees and Hartlepools	86	187,305	115,975	46	122,733	69,025
The Wear	58	173,673	124,205	57	132,633	95,556
Royal Dockyards	4	52,521	.....	6	46,612	.....
Mersey to Solway	95	41,835	144,801	92	85,228	164,950
The Humber	77	28,033	42,710	72	24,414	35,375
The Thames	142	11,532	30,680	96	7,053	11,618
English Channel	93	11,373	128,969	104	9,920	68,101
Bristol Channel	56	9,176	700	57	5,399	762
Ireland	...	167,102	137,730	...	120,904	123,750

It will be noticed that, with the exception of the Clyde and the Mersey to Solway districts, there was a substantial gain in all parts of the United Kingdom. The decrease on the Clyde was due very largely to labor troubles, which resulted in the shipyard lockout, and does not give a true indication of the condition of business. On the whole, the amount of work turned out on the Clyde has been very satisfactory, and, in view of the large number of orders which are now in hand, the prospect is exceedingly good. There has been a falling off in warship tonnage, although in one case, that of the Fairfield Shipbuilding Company, a record was made by building complete seven destroyers within the year. Also at the Clydebank yard of the John Brown Company, a cruiser and three destroyers were built, which is also a good showing. The Fairfield Shipbuilding Company have to their credit the production of the largest total indicated horsepower of engines of any firm in the United Kingdom, although Messrs. Harland & Wolff approach very closely their figures. The largest merchant vessel built on the river during the year was the *Roturua,* 11,130 tons. This vessel is also notable as the third vessel to use the combination of reciprocating and turbine engines. At present there is an enormous tonnage of both naval and mercantile shipping in hand on the Clyde, and the coming year should prove a record breaker. The placing of the contract for the Cunard Line's new mammoth liner with John Brown & Company is the most important order for merchant ships now in hand.

Nearly all English shipyards report a revival in trade and good business prospects for the coming year. On the Tyne are building the Cunard steamer *Franconia,* at the yards of Messrs. Swan, Hunter & Wigham Richardson; the battleship *Hercules,* at Jarrow; cruiser *Weymouth,* at Elswick, and three destroyers at Hebburn. Messrs. Swan, Hunter & Wigham Richardson have to their credit the largest tonnage launched on the Tyne during the last year. On the Wear, a district which suffered severely during the recent depression, the shipyards have been extremely active during part of the previous year, and have a good volume of business on hand for the coming year. The largest merchant work is being carried out at Sunderland, where two vessels for Norwegian owners are being built which will have a carrying capacity of 12,500 tons each. As previously stated, the Mersey to Solway district showed a decrease in the total tonnage built in 1910, and this is largely due to the fact that no large warship was launched during 1910. A large amount of engine building was carried out, however, and for the coming year a contract has been placed at Barrow for a Japanese *Dreadnought.* Here also a British cruiser is being built. The British Admiralty have also placed an order for a first class battleship at Birkenhead.

The foregoing review, although brief, is sufficient to show the general revival in shipbuilding which has occurred in Great Britain and America during the last year, and when it is noted that according to Lloyd's statistics the total work now on hand in Great Britain is 20 percent greater than was the case a year ago, it is evident that the prospects for the coming year are very good.

Launch of the Arkansas.

The United States battleship *Arkansas* was successfully launched at the yards of the New York Shipbuilding Company, Camden, N. J., Saturday, Jan. 14.

The *Arkansas* is 562 feet long over all, 554 feet long between perpendiculars, 93 feet 2½ inches breadth on load-waterline, with a mean draft of 28 feet 6 inches. The full-load displacement will be 27,243 tons; the normal displacement, with two-thirds supply of stores and fuel and full supply of ammunition, 26,000 tons, and the estimated displacement on trial, 26,000 tons. The ship is to be driven by Parsons turbines on a four-shaft arrangement, which it is estimated will develop a total of 28,000 shaft horsepower, giving the vessel a speed of 20½ knots. A bunker capacity of 2,500 tons is provided and 400 tons of oil fuel will also be carried. The boilers are of the Babcock & Wilcox watertube type.

THE LARGEST BATTLESHIP AFLOAT.

The armament of the vessel will consist of twelve 12-inch guns mounted in pairs in turrets on the center line of the vessel, and twenty-one 5-inch rapid-fire guns for defense against torpedo-boat attack. There will also be four 3-pounders, two 1-pounder semi-automatic guns, two 3-inch field pieces and two .30-caliber machine guns. Two 21-inch submerged torpedo tubes complete the armament.

The construction of the *Arkansas* was authorized March 31, 1909, and the contract with the New York Shipbuilding Company was signed Sept. 15, 1909. The keel was laid Jan. 25, 1910, and the ship will be completed May 25, 1912. The contract price of hull and machinery was $4,675,000 (£963,000). She is being built under the supervision of Naval Constructor J. G. Tawresey.

$761.59 SAVED WITH THREE OUNCES OF VANADIUM STEEL

A TWO years' test of Vanadium against ordinary steel in a large railroad shop shows an actual saving of $761.59 on a single item—a flue cutter weighing three ounces. In one year 1049 carbon steel cutters were used to cut 145,444 flues,—in the next year 68 Vanadium steel cutters cut 152,578 flues. The average number of tubes cut with the carbon steel tool was 139, the average for the Vanadium steel, 2,244. The cost of the carbon steel cutter per hundred flues was 54 cents, compared with 1-6/10 cents per 100 with the Vanadium steel tool.

THIS means that there has been a revolution in making steel—what we call steel is a relic of the past compared to the new Vanadium Steel. In final cost Vanadium Steel is the cheapest high-duty metal known. In actual service it is the strongest, toughest, most elastic and longest lived steel that can be made.

In workability it melts, welds, rolls, forges, stamps and machines like ordinary steel. It is made in many types for many uses; you can buy it from any reputable steel maker; it costs less than ordinary steel, service considered.

Vanadium Steel means safety, economy, vitality, strength and service. Specify it, use it, save money by it and guarantee your product and your profits on it.

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MARINE ENGINEERS

SHOULD SPECIFY THESE METALS—

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This Bronze composition is particularly adapted for Modern Marine Service, and is rendered tough, strong and uniform by the incorporation of Vanadium, which is considered the greatest of all scavenger alloys, imparting to the metal greater wearing qualities. This bronze is ten per cent lighter in actual weight than any other bronze casting of the same pattern.

These castings can be forged.

The structure is close and clean, capable of withstanding high pressure for valve service.

A cylinder 9-16 of an inch thick, three inches in diameter and fifteen inches long has been subjected to a pressure of nine thousand pounds.

TENSILE STRENGTH on 1" Section:
56000 to 65000 lbs. per square inch.

ELASTIC LIMIT:
22000 to 34000 lbs. per square inch.

This metal is used in submarine vessels in Japan, Austria, Russia and every vessel of this type in the United States.

VICTOR VANADIUM
NON-CORROSIVE SILVER METAL

This Metal is non-corrosive and is particularly useful for sea-going service.

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It is an ideal metal for propellers, for it withstands salt water and all vegetable and mineral acids, nitric acid excepted. It is of great strength and toughness and should be used for valves and couplings for fire apparatus on account of its non-corrosive qualities, in place of nickeled castings, as nickel finally peels off, and this metal not being plated, cannot peel.

TENSILE STRENGTH:
66000 lbs. per square inch.

ELASTIC LIMIT:
36000 lbs. per square inch.

This metal will be found indispensable to marine service when once used.

WRITE FOR CATALOG

VANADIUM METALS COMPANY

FRICK BUILDING

PITTSBURGH, PENNA.

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Air-Pump Troubles.

One of the contractors of an English insurance company has stated that about one-third of all engine accidents are caused by air pump fractures, and every engineer knows that air pumps, with their valves, seats, etc., give the most trouble. The valves are of either india rubber, fiber or brass. India rubber valves are incapable of withstanding high temperature water, so that they seldom last long; fiber valves are better, but the best are brass valves, especially if made of Kinghorn metal. With brass valves, the vacuum in the condenser falls away by leakage rather quickly after the stopping of the engine. With fiber valves this action is not so quick, and with rubber valves there is little leakage. If the valves are placed vertically, they must always be of india rubber (for instance, such is often applied for circulating pumps), as brass or fiber valves do not work well in this position.

The quality of fiber used for valves must be very good indeed. Some are very untrustworthy, as they swell when the

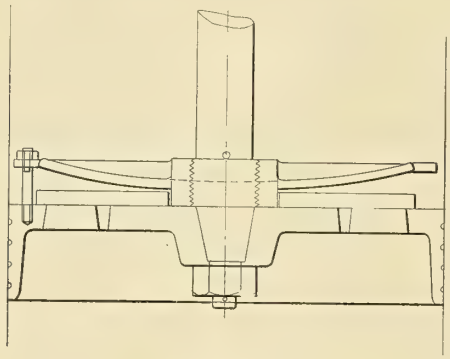


FIG. 1.

valve becomes wet. Such an occurrence happened on board the tug *M. C.* The fiber valves of the air pump, which was connected to a jet condenser, were flat and, as is usually the case, there was not very much space around the valve. After some months' running, the vacuum became very poor, the pump was dismantled and it appeared that all valves had swelled, the bucket valve becoming 7/8 inch larger in diameter

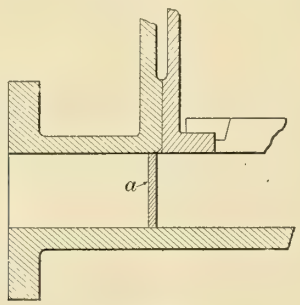


FIG. 2.

and about 1/8 inch thicker. The ring space around the valve had become very small and the lift was too slight. Therefore, the resistance of the passing water had become too great for the guard to stand and this had broken in four pieces.

Another valve guard was made (Fig. 1), not flat, but curved. A smaller thickness of fiber was taken and in addition, the guard was secured to the piston by four studs, so that it could not bend or break. This fiber was of much better quality and when wet it bent with ease. After these repairs, the valves gave no further trouble and they have lasted for a reasonably long time.

It is not good practice to have foot valves of air pumps made of fiber. Brass valves are better for this purpose, as sometimes these valves remain open a moment and then fall down; thus giving a disagreeable shock in the pump, which is heard from time to time. When such a foot valve is replaced by a brass one the shock is eliminated.

It often happens that when the air pipe from the top of the hot well is led overboard and is bolted at the ship's side

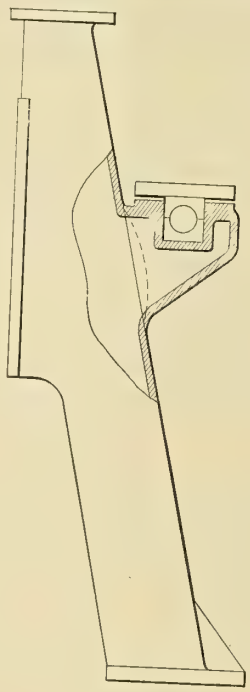


FIG. 3.

to a non-return valve, the feed pump does not work and the feed water is taken overboard with the air. The cause of this is that, when in the single acting pump the bucket is rising and the air lifts the non-return valve, the rush of air is such that a partial vacuum is formed in the pipe. The water in the hot well is sucked up into the waste pipe and with the falling stroke of the pump it is discharged overboard. If a small tube is placed in the waste pipe and led upwards, the air may go back and the feed pump will perform its duty again. In this small pipe a cock must be placed, and also in the pipe from the under side of the hot well. When the engine stops, these cocks must be shut so that the vacuum cannot fall back.

The packing of air pump pistons is often very inefficient. In some types of pumps grooves are turned in the piston, but these water seals are scarcely sufficient. In ordinary pumps, rope packing is much used, but the best packing is formed by small brass springs. These must lie against the cylinder with very little tension, so that they can never break; since if they should break they would do much harm in the pump.

In one case known to the writer, where a triple expansion

engine was installed, it was impossible to get any vacuum in the condenser; and it appeared that the air pump did not pump water, either. The valves were taken out but were found in good order; then it was thought that the pump base was burst, but this did not seem to be the case; finally one of the men suggested that perhaps no hole had been made in the packing between the condenser and the air pump flange. Therefore, the pump was taken off, but the packing was found in good order. It was now found, however, that in the pump base was cast a thin wall (Fig. 2), caused, presumably, by the shifting of the core when cast. The water and air could not flow towards the air pump, so that it was impossible to get any vacuum. This wall was taken away and then the pump worked satisfactorily.

For the design of pump gear, the pressure on the pistons is taken as 30 pounds per square inch, and with this pressure the stresses of the parts are taken rather low. It might happen, however, that this pressure would be taken too low, as the following will show:

In the tug *W* there was placed a compound engine with a jet condenser of the ordinary type with the air pump placed behind the low-pressure column. The pump was driven from the low-pressure crosshead by cast steel levers (Fig. 3). The bracket for the bearing was cast to the after column. When the tug was towing in very low water, the screw touched a large stone and three of the four blades were torn off. At this moment the engineer was on deck, and as the fireman did not know anything about the engine there were four or five minutes when the engine raced tremendously and the air pump made a terrible noise. When the engineer succeeded in stopping the engine, a sharp knock was heard, and the whole bracket fell down and was moved up and down by the final revolutions of the engine. The pump crosshead was bent and also had to be renewed. The boat was towed to the engine works, where a new column was ordered, with the bracket made stronger.

To prevent accidents of this kind, some engine works make the bolts for the pump links very weak so that they will break before any other part. Some reserve bolts are then supplied and a few hours' work putting in a new bolt will repair the break.

D. K.

A Little Comparison.

A great difference exists as regards the procuring of "tickets," or licenses, for marine engineers in America and in England. In America, a man must be a citizen before he can even go before the Inspectors to pass for his license. He must show a reasonable period of time of his connection with engine work. An engineer must be licensed before he can have charge of a large plant, and it cannot be wondered at that an employer wants some security on his engines and boilers, as anyone without a knowledge of machinery might apply for and succeed in getting a job in connection with such, with disaster to everybody and everything.

In Great Britain, on the other hand, a man of any nationality can apply for permission to "get his ticket." Three grades are in force there; second, first and extra chief's. The latter is only tried for by engineers to prove their superior knowledge, and is in no way bound to be got by the engineer to obtain the highest positions on any boat. The second engineer's certificate entitles him to take any position up to and below that of second engineer, while the first allows him to take complete charge over engines and boilers, as chief engineer. It often happens, of course, that the low grade certificate engineer holds the first-class ticket, or license, and is only waiting his turn for promotion.

A man may get permission to sit for his examination, on condition that he has served five years in a machine shop and twelve months at sea, or three years in a shop and three to four years at sea, as sea time counts only one-half that of shore time, until the candidate has "put in five years," apprenticeship or its equivalent.

If he fulfills the conditions he must pass an examination in arithmetic, engineering subjects, and drawing, and then if these are passed he has to satisfy the inspector that he can answer various questions put to him orally—a test which lasts from one-half to two hours.

As there are no examinations for stationary engineers in England, of course they do not require a license for such a job, but a great preference is given to a marine engineer holding his certificate when a position is open over his dry-land brother who is not so fortunate as to have "followed the sea."

HANK.

A Repair to a Broken Slide Spindle Gland.

When a junior goes to sea he is sometimes apt to be more trouble than good, and an instance of this sort occurred on board a vessel making a long voyage where a junior, whose strength was in excess of his wisdom, broke a piece completely off a slide spindle gland, owing to hammering the gland up in order to drive the packing in, as he was repacking the gland.

Fig. 1 shows the shape of the fracture, and it will be seen that a segment of the flange was knocked completely off. In order to repair this an iron ring was made of slightly smaller

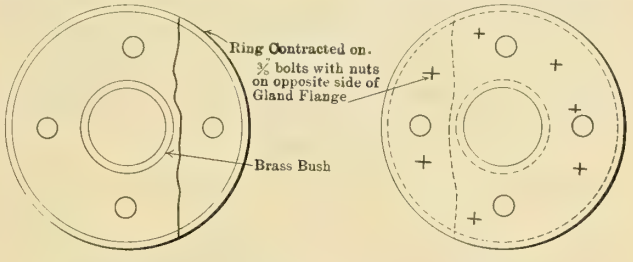


FIG. 1. FIG. 2.

internal diameter than the outside diameter of the flange. This ring was heated up to redness, and after the broken piece of the flange had been put back into place the ring was slipped over and contracted on by cooling. In order to make a thoroughly strong job of the repair a piece of ⅜-inch plate was cut to the same size as the gland flange, and holes cut in it for the spindle and studs of the gland to pass through; ⅜-inch holes were then drilled through the gland flange, and the plate was secured by ⅜-inch tap bolts and nuts both to the gland flange and to the broken piece (Fig. 2). In this way the repair, which was at first regarded as temporary, was made strong enough to become a permanent job and the gland is still in service.

THOMAS BEACH.

A Ship on Fire at Sea.

Probably one of the most trying experiences which any marine engineer could encounter is to have to devise some means of coping with fire on board his vessel. The means for fire fighting are, of necessity, found to be of an inadequate description on board the majority of cargo vessels unless the fire happens to be discovered at a very early stage, and much then depends upon the ingenuity of the men on board as to whether they will bring their vessel and cargo home to port in safety. Most owners of vessels do the best they can to provide means for subduing a fire, but in the nature of things the chances on board a vessel are very much in favor

of the fire. On one ship, which loaded cotton at Galveston in the United States, a fire was discovered in one of the holds when the vessel was about a week out of port on its way to Liverpool. Very shortly after the fire was discovered the decks above the fire began to warp with the heat. As soon as the outbreak was discovered the engineers on the vessel tore down a few pipes from the connections in the engine room, broke the joints in the deck steam pipes and cut three holes in the deck above the fire in the hold. The pipes from the engine room were then fitted to the deck steam pipes, and steam was turned on to the fire in this way. At the same time the ship was turned round and steered for Halifax in Nova Scotia. The steaming of the hold in this way kept the fire down considerably and made the combustion a slow one. But things got gradually worse, and the firemen could not steam the ship, inasmuch as extra feed often had to be put on. This was necessary owing to loss of water, as the steam to the hold, of course, gave back no fresh water to the boiler. The donkey boiler was set away, but it soon became salted and after three days it was found to be leaking all over. Moreover, the main boilers were also starting to leak. In order to keep the density down, the boilers had to be blown down very frequently, and this involved extra feed over and above the loss occasioned by the fire.

After 12 days the vessel managed to reach Halifax, when it was possible to obtain steam from the shore. Even then, it took another 14 days in order to get the fire put out entirely, and after everything was over, the ship's decks, over the fire, were warped into a series of corrugations, just like a lot of small hills and hollows. After the necessary repairs to the boilers, which were considerable, and when the burnt cargo had been got rid of, the vessel started again for Liverpool and got home safely and the owners of the vessel gave the engineers a very handsome recognition of their service in connection with their fight against the fire. Fireman.

High-Pressure Cylinder Side and Bottom Knocked Out.

The steamship "A———" was on a voyage from London to Glasgow, when the above accident happened. She was a ship of 1,600 tons net register, with compound engines of 220 nominal horsepower and cylinders 40 inches and 74 inches in diameter, respectively, with a stroke of 36 inches. She was about half way on her voyage and just off the coast of South Wales, when the bottom and side of the low-pressure cylinder were knocked out. The cylinder cover was broken and the piston was split into five pieces; the low-pressure piston rod was twisted and bent in a most extraordinary manner; the high-pressure piston rod was broken through one of the cross-head bolt holes; the valve gear of both engines was bent and strained seriously, owing to the pieces of the broken cylinder getting among the valve gearing; and a lot more damage was done which could not be ascertained while we were at sea.

The engineers then started and disconnected the engine, and, after a lot of work, the high-pressure engine was started and the remaining 300 or 400 miles were made and the vessel reached port safely. Considering the defective state of the high-pressure rod, and that the whole of the waste steam was discharged into the engine room, rendering it almost inaccessible, some credit, I think, is due to the chief engineer and his staff for their coolness and hard work in such an emergency.

Upon examination of the damaged machinery, after the vessel had reached port, it was found that the whole bottom had been knocked out of the low-pressure cylinder, a large piece of it, several square feet in area, had been driven out among the machinery and valve gear, several pieces weighing from 40 to 90 pounds had been thrown to different parts of the engine room and between the high-pressure eccentric rods. The stuffing box gland was also broken and rendered useless, the after side of the cylinder, at the middle of its length, was also forced out, causing a large rent; the cylinder was cracked down through the valve casing face, showing daylight through the aperture.

The accident is considered to have been due to the priming of the boilers under steam, owing to their small diameter. They were double ended, with a steam drum placed horizontally between them and running through the uptake, this drum was filled with gulps of water without warning, which was carried over into the engines before any precaution could be taken to slow the mdown; it was afterwards decided to fit a drain cock on the drum, which gave the engineer a chance to clear out the water periodically.

F. J. S. N.

Trouble with the Feed Pump.

There is nothing more harassing to an engineer in charge of a vessel than to find parts of his auxiliary machinery always going wrong, and in one vessel considerable trouble was caused throughout a voyage owing to the erratic behavior of the feed pumps.

After making an examination of the lifts of the valves and doing everything possible to find out the cause of the trouble, the conclusion was arrived at that the source of trouble must be something wrong with the main check valve. This it was imagined was possibly "jambed" or was "gagging." For this reason the boilers were fed for the remainder of the voyage by drawing the water from the hot well by means of the donkey pump and filling into the boilers by way of the donkey checks. There were two boilers on board this vessel, but in neither case was it possible to get the feed properly adjusted, even with the main check valves full open, the feed-water just overflowing and running into the bilges.

By using the donkey pump as already explained, the vessel was brought home to port and there the boilers were opened out. On examination it was found that the internal pipes fitted within the boiler to carry the feed-water up inside had been perforated throughout their lengths with small holes. These holes had, during the voyage, become filled up, and this was the cause of all the trouble. The engineer who discovered what was wrong got a cross-cut chisel and joined all the holes together, making long slits in the pipes, and there was no further trouble from this source.

It will be found in marine work that internal pipes in boilers, except those which fit to the scum-cocks, are nothing but a source of trouble and are of very little use. When they are attached to check valves they are apt to corrode and fall off, and when this happens the feed-water, which is cold in comparison with the water already in the boiler, is sometimes projected against the combustion chamber plates, and these are consequently so much weakened at the point where impinging takes place that they frequently give out at this point. For this reason the matter is of more than secondary value.

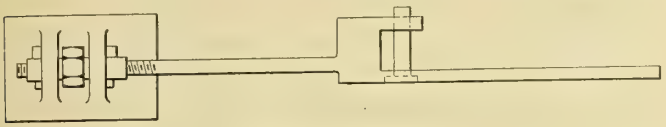
H. P. Rolfe.

A Broken Winch Valve Spindle.

Owing to the constant wear and somewhat rough treatment which ships' deck winches receive, there is frequently a good deal of trouble through unexpected breakdowns, and it may be of interest to record a repair which was made on a winch valve spindle of mild steel which was broken in service. It is not claimed that this is the most perfect repair that could have been made; as a matter of fact an unnecessary piece of work

was done, which will be pointed out later. As one learns, however, just as much from mistakes as perfect work it is worth while drawing attention to the repair as it actually occurred.

The sketch shows a view of the winch valve spindle and the valve itself, illustrating exactly where the valve spindle was broken through. This was brought about either by the way the nut constantly shook upon the spindle or by the corrosion of the spindle itself at the portion within the brass nut, probably due to electrolytic action. The repair was made as follows: The parts were taken adrift and the holes in the ribs on the back of the valve were filed out large enough to allow a piece of tube to pass through. This tube was screwed inside over its entire length with a ¾-inch thread, and the tube was next screwed upon the length of the spindle, the broken piece then being screwed into the tube so as to meet the long end. For some reason or other the hole in the nut was also filed out



VALVE WINCH SPINDLE.

to allow the tube to pass through, and the nut was placed in position between the two ribs before the tube was threaded through the large holes in the ribs. There is no reason why this should have been done, as the nut was of no use after the repair was finished, and the engineer who did the work and who could not explain why he troubled with the nut was considerably chaffed about the wasted time. As the breakdown occurred at night, however, when the ship was discharging her cargo, there may be some excuse for a mistake of this kind.

In order to keep the tube and spindle in proper position with relation to the valve two cotter holes were cut right through the tube and spindle, as shown in the sketch. These cotter holes were made by drilling three ¼-inch holes close together and then chipping through the metal between them with a cross-cut chisel. The cotters, which were then driven in through the tube and spindle, bore close up against the ribs at the back of the valve, and thus held the valve rigidly in its proper position. This repair lasted throughout the whole voyage without giving any more trouble, and due credit must therefore be given to the engineer who did the work.

S. I. BROWN.

Temporary Repair of a High-Pressure Slide Valve Spindle.

In a vessel which was steaming between the Tyne and Genoa, a breakdown occurred in connection with a high-pressure slide valve spindle, which, as it is fairly typical of the unexpected occurrences which the marine engineer meets at sea, may be of interest to other readers.

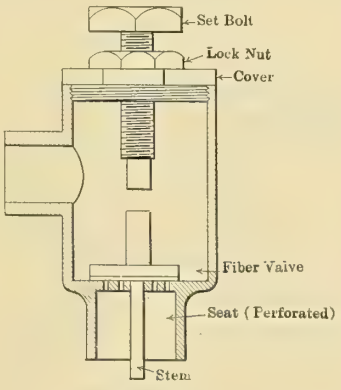
For some considerable time it had been noticed that the threads on the spindle were somewhat worn, allowing too much play to take place between the valve and its nuts, but it had been considered that this could go on for some little time longer before overhaul and repair. On the occasion of the accident, however, the threads on the spindle and those of the nuts were completely stripped, and this left the valve independent of the spindle. While the latter would work up and down the valve was fast against the face on the steam chest and the engine naturally stopped at once. As it was necessary to get the ship into port as quickly as possible temporary means were adopted to remedy the defect. The slide valve spindle was taken out and four holes were drilled along the length of the spindle side by side, and by cutting the metal away between the holes and filing up, a hole was made for a cotter about ⅜ inch thick by 3 inches wide. This was driven in above the nuts and held them in place, the cotter being secured by means of a ¼-inch split pin. The steamer was enabled to finish the round voyage with this repair, and on arrival home the threads on the spindle were cleaned up and new nuts were made. The cotter had, however, proved its efficiency so well that it was decided to keep it in place as an extra safeguard against any slacking back or stripping on the nuts, and for this reason it is described here, as it may be of use to other men in charge of marine engines.

An Ice-Making Experiment.

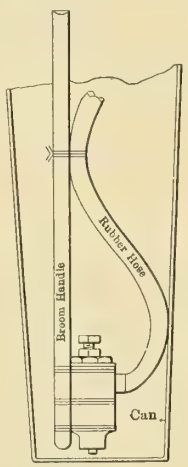
Much ice is used on a modern passenger transatlantic liner, and most of this is made on board. The ice-making process is often a source of worry, for the ice must be "clear" and not cloudy. The presence of air bubbles in the water as the freezing process is going on causes the ice to turn out cloudy. This is taking it for granted that the water is as pure as can be procured. The ice is made either in a pail by the cold-air system or by the "rocker" principle, which comprises a number of wedge-shaped cans filled with water and immersed in cold brine, and kept rocking slowly by a motor to expel the air.

In a case where the ice was made by the latter method trouble was experienced with the ice coming out cloudy. The cans were all tested to make sure they were tight and were regalvanized, but still with the same result. Something had to be done, for the ice was for table use. The cans were usually filled with a 1-inch rubber hose; but this was a sure way of making air bubbles, especially if the hose did not reach the bottom of the can, so we devised the following to overcome this:

One of Lewis's Patent Pet Valves, shown fully in the sketch, was bound on to a common broom handle and the rubber hose fastened to it, as shown. The water used was first boiled in



LEWIS'S PATENT PET COCK.



PET COCK IN PLACE.

one of the cooking boilers and allowed to cool; it was then allowed to flow through to the pet cock, which was held down in the can, upright, by the broom handle. The stem under the fiber valve protruded beyond the end of the body of the cock about ¼ inch, almost the same lift being allowed the valve, and the action of all depended on this stem, as the same had to be pushed against the bottom of the can to allow the water to enter the can, thereby ensuring that the outlet for same was as low as it was possible to get.

When all the cans were filled, twelve in number, the brine was allowed its flow and the motor started. When made the ice, though not exactly perfect, was a good improvement upon the batches previously made by the same rocker when filled direct from the hose, proving that the main trouble was that otherwise useful fluid—"air."

M. J. L.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Progress in Marine Engineering and Naval Architecture.

The year 1910 has been productive of no startling or unlooked-for developments in either marine engineering or naval architecture. Continual progress has been made, however, along lines which have been more or less firmly established by previous development. As we have predicted in previous issues, no attempt has been made to build large merchant ships of extreme speeds, but the question of speed still remains an important one in certain types of naval vessels. The construction of a large number of turbine-driven destroyers and battleships which, on trial, have nearly all exceeded their designed speeds, in some cases by several knots, emphasizes the capacity of the steam turbine for generating large powers when forced to the limit. Greater perfection has been attained in the design of condensing apparatus in the last few months, and perhaps it is largely due to this reason that better results are continually being obtained with steam turbines, both as regards economy and the development of high powers per ton of machinery weight. Since the question of speed has been largely confined to warship construction, the use of steam turbines in merchant ships has not increased with any great rapidity. Only comparatively few merchant vessels have been completely equipped with steam turbines during the last year, and, in spite of the good results obtained in certain intermediate types by the combination of reciprocating engines and low-pressure turbines, this arrangement is adopted only in a few cases. The excellent results obtained during the year with the steamer *Vespasian,* which is fitted with Parsons turbines and spur reducing gear, whereby the water consumption of the vessel for all purposes was decreased 10 percent below the most economical results obtained with reciprocating engines, argue very strongly for the adoption of this mode of propulsion in cargo vessels of moderate speed. The results which will be available in a few months from the United States collier *Neptune,* which is being fitted with Westinghouse-Parsons turbines and the Melville-Macalpine reducing gear, will give additional data regarding the efficiency of this method of propulsion which, if expectations are met, will undoubtedly do much to advance the cause of the steam turbine. Aside from speed, there is one characteristic of merchant vessels which has developed remarkably during the year, and that is size. The construction and successful launching of the White Star Liner *Olympic* are but the beginning of an era of construction of vessels of immense tonnage, though of moderate speed. It is quite likely that orders for more vessels of this type will soon be forthcoming.

At the beginning of 1910 sweeping claims were made for the immediate development of oil and gas engines for marine purposes, but up to date developments in this direction must be sought largely within the confines of experimental laboratories and workshops. Much experimental work has been done to good purpose, however, and, from present indications, the coming year, or at least the immediate future, will witness a remarkable development in this direction. The activity of a number of British and Continental engine builders in the development of a practical two-stroke, double-acting, reversible Diesel engine has resulted in orders being placed for a number of vessels to be propelled by such engines; the average power, however, is comparatively small. Extensive experiments have been made with single cylinders developing large powers; but the results have, so far, not been made public, nor have any practical designs yet appeared involving these characteristics. Apparently less attention has been given to the development of suction gas plants than to the oil engine, but moderate-sized plants of this type are now under construction in America. One of 300 horsepower, the engine being of the four-cylinder, four-cycle, inclosed crank-case type, is already completed, and another, developing 500 horsepower on two shafts, will be completed in the spring. The increased activity which is manifest in

the development of the oil engine will undoubtedly have a good effect upon the development of the internal-combustion engine using producer gas, and, as the results obtained with the earlier installations become better known and the difficulties and disadvantages are gradually overcome, the installation of these plants in comparatively large sizes will be a matter of course.

Internal-combustion engines for motor boats and small commercial vessels have reached a high state of efficiency, and the designs for small power boats themselves, particularly those for cruising purposes, have attained a high degree of perfection. This branch of marine engineering has developed in America to a greater extent than elsewhere, due to the great demand for boats of this type. The influence of long-distance ocean racing has been very beneficial, and, as a result, motor boats, varying in size from 40 feet to 100 feet over all, have been turned out which combine exceptional qualities of seaworthiness and reliability. The engines, for the most part, are of the four-cycle, single-acting type, and, until some cheaper fuel than gasoline (petrol) is available, it is doubtful if the double-acting engine will be much in demand. The field of the small internal-combustion engine is not necessarily restricted to specially designed motor boats, but, as we have frequently pointed out, there is an adaptation which has attractive possibilities from a financial standpoint, and that is the use of internal-combustion engines operating on some cheap or moderate-price fuel for use as auxiliaries in large sailing vessels. The usefulness of sailing vessels as cargo-carriers in competition with tramp steamers has gradually lessened in recent years, simply because the sailing vessel cannot be relied upon to maintain a schedule, whereas the power-driven boat, although more expensive to operate, can be depended upon to maintain a certain average speed. The use of auxiliary power in large sailing vessels would place them upon an equal footing with the tramp steamer, as far as the maintenance of an average speed is concerned, and would give them a decided advantage, since the power required would be small and the engine would be needed during only part of the voyage. The successful use of oil engines in English fishing boats and trawlers is a development which at least points the way towards the re-establishment of the sailing ship in commercial navigation.

Improving the Economy of Reciprocating Engines.

Mr. Morison's paper on the "Economical Working of Reciprocating Marine Engines and Their Auxiliaries," which we print elsewhere in this issue, merits the careful attention of both sea-going and superintending engineers. The author's recommendations relate to the proper vacuum for reciprocating engines and the disposal of the exhaust from the auxiliaries so as to improve the economy of steam consumption. He states that there are hundreds of vessels now operated in tropical waters where the best vacuum obtained is from 20 to 22 inches, and it is not considered worth while to attempt to obtain any better results, although if the engines and condensing apparatus had been suitably designed to carry a vacuum of 27 inches in the tropics and the feed heating arrangements had been adequate, a saving in steam consumption as great as 10 percent might have resulted. In view of these facts, he considers that there are economic possibilities in reciprocating engines which have been allowed to remain latent, and, while considerable attention has been given to means for obtaining higher vacua in the effort to improve the economy of steam turbines, the possibility of a similar gain in the case of reciprocating engines seems to have been overlooked. In the author's opinion, the design of the engine itself offers no hindrance to the use of a high vacuum if the proper cylinder proportions and adequate exhaust ports and passages are provided, and he quotes the results of tests to show that the power increases and the steam consumption per brake-horsepower decreases with approximate uniformity up to the highest vacuum that can reasonably be carried on a steamship. After pointing out that the air-withdrawing capacity of an air pump may be regulated by varying the temperature of the pump, he describes a simple form of temperature regulator to accomplish this. With the assurance, therefore, that a high vacuum can be obtained even in tropical waters, and that the economy of triple and quadruple-expansion engines will be directly increased thereby, he turns to the disposal of the exhaust from the auxiliaries, which constitutes about 15 to 20 percent of the total steam generated in the boilers, and shows how about 95 percent of the heat which it contains can be returned to the boilers by using it to heat the feed-water to the limit at which the ordinary ram feed pump will work. This arrangement of condensing and feed heating apparatus obviously involves important economic advantages, and it will well repay investigation by any engineer who is in the habit of working with a low vacuum in the condenser simply to obtain a high temperature of air pump discharge water and who then throws away heat by exhausting the auxiliaries into the condenser, because the feed-water is already as hot as can be handled by the feed pumps.

There are, however, other considerations involved in the problem which must not be overlooked. For instance, the amount of circulating water required in obtaining a high vacuum is vastly more than is necessary for a low vacuum, and the power required to pump this extra water will be considerable. Thus, in making any changes to improve the economy in steam consumption of the main engines, any possible increase in the amount of steam required by the auxiliaries should be carefully investigated, to see that a positive increase results in the over-all efficiency of the plant.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.

	Tons.	Knots.		Dec. 1.	Jan. 1.
Florida	20,000	20¾	Navy Yard, New York.....	83.7	86.7
Utah	20,000	20¾	New York Shipbuilding Co..	92.3	94.3
Arkansas ...	26,000	20½	New York Shipbuilding Co..	52.8	55.4
Wyoming ...	26,000	20½	Wm. Cramp & Sons.....	46.3	48.6

TORPEDO-BOAT DESTROYERS.

Sterrett	742	29½	Fore River Shipbuilding Co..	99.0	100.0
McCall	742	29½	New York Shipbuilding Co..	96.2	99.1
Burrows	742	29½	New York Shipbuilding Co...	96.0	96.3
Warrington..	742	29½	Wm. Cramp & Sons.....	91.2	92.7
Mayrant	742	29½	Wm. Cramp & Sons.....	90.3	91.3
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	55.5	61.7
Trippe	742	29¼	Bath Iron Works.....	81.2	87.0
Walke	742	29½	Fore River Shipbuilding Co..	73.2	77.5
Ammen	742	29½	New York Shipbuilding Co..	79.9	82.0
Patterson ...	742	29½	Wm. Cramp & Sons.....	54.4	57.9

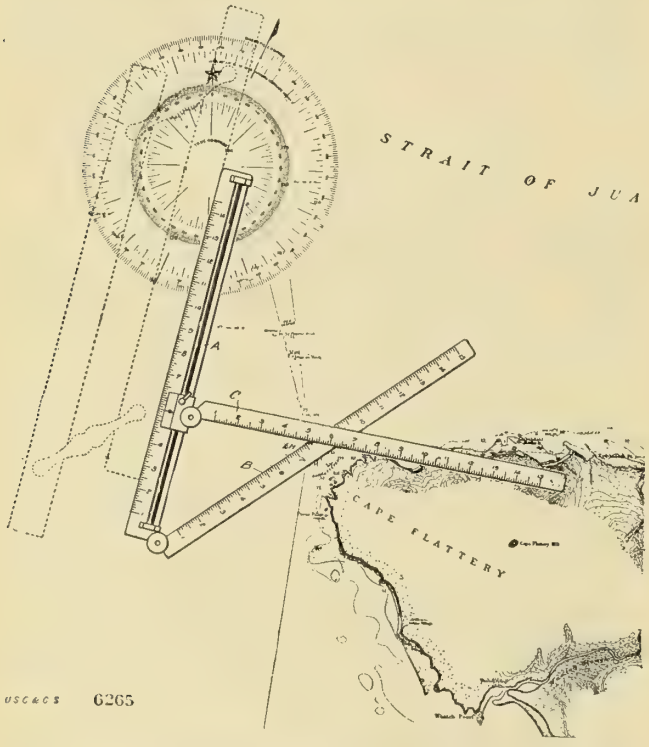
SUBMARINE TORPEDO BOATS.

Seal	....	....	Newp't News Shipbuilding Co.	72,9	73.7
Carp	....	....	Union Iron Works.....	74.0	78.2
Barracuda ..	....	....	Union Iron Works.....	75.0	78.2
Pickerel	....	....	The Moran Co.....	68.0	71.0
Skate	....	....	The Moran Co.....	68.0	70.9
Skipjack	....	....	Fore River Shipbuilding Co..	62.2	74.9
Sturgeon ...	....	....	Fore River Shipbuilding Co..	64.3	71.8
Tuna	....	....	Newp't News Shipbuilding Co.	46.7	47.6
Thrasher ...	....	....	Wm. Cramp & Sons.....	23.0	26.9

ENGINEERING SPECIALTIES.

A Fogometer.

An instrument has been devised by W. J. Smith, Maritime Building, Seattle, Wash., for accurately determining a ship's position (both as to the bearings of and the distance from a lighthouse, etc.) in foggy weather by the use of wireless telegraph and sound waves. The instrument depends for its operation upon the relative velocities of wireless and sound



waves. If a wireless station sends a "wireless" simultaneously with the regular sound signal used during fog, the time interval in seconds between the tick of the wireless instrument on board the ship and the moment when the sound signal reaches the ear, multiplied by 1123 and the result divided by 6080, will equal the distance of the ship from the lighthouse where the signals were given, and the ship will be somewhere on the arc of a circle, at that distance from the shore station. Now, if the ship be run on her course for a certain distance by log, and her position again determined by wireless and sound, she will again be somewhere on the arc of a circle at a distance from the shore station corresponding to the last observation. These observations furnish data for the three sides of a triangle, by means of which the exact position of the vessel can be determined. If the vessel and wireless station are equipped with submarine signalling apparatus, this can be used instead of the usual fog signal, using, of course, different constants in the calculation.

The Fogometer consists of three scales, one of which (A) is laid parallel to the course of the vessel, and which is graduated to show the distance traveled by the vessel between observations and two hinged scales, one of which (B) is mounted at one end of the fixed scale and the other upon a sliding block, so that it can be set to the distance traveled by the vessel. These two movable scales are graduated to correspond to the distances of the vessel from the shore station, as found by the two sets of observations. By placing this instrument on the chart, parallel to the ship's course, and properly adjusting the scales to the values found, the position of the vessel is shown at once.

Shore stations may be called upon to dispatch sound and wireless waves simultaneously, at intervals as desired, during fog, and by this means the navigator can determine his position with considerable accuracy.

Williams Spark Plug Wrench.

J. H. Williams & Company, 150 Hamilton avenue, Brooklyn, N. Y., have just placed on the market a ½-inch spark plug wrench which involves a concentration of service, in that the tool has a "box" end adapted for use as a ½-inch spark plug

wrench and an "open" end suitable for tire lugs, ⅜-inch United States standard cap screws, ⅜-inch A. L. A. M. standard nut and cap screws and 9/16-inch set screws. The tool is drop-forged from steel, and has been designed for convenience and reliable service about automobiles, motor boats, internal-combustion engines, etc.

The Ingram Fuel Oil Burner.

Recent interest in fuel oil as a source of power for marine and stationary plants has brought into the market numerous devices of more or less merit for converting the crude oils and residuum used for this purpose into a highly combustible gas or vapor at the furnace. As is generally the case in the development of a new field in engineering, the natural tendency has been to the extremes in design. On one hand, there are a number of burners that are very effective in bringing the oil to a highly combustible state, but they are so complicated with intricate and delicate parts as to render them impracticable for the severe usage to which they must necessarily be subjected; while, on the other hand, there are numberless so-called burners with claims to simplicity whose sole function is to inject the oil into the furnace regardless of its efficient combustion.

In Figs. 1 and 2 is shown the Ingram burner, which it is claimed combines both simplicity and efficiency. It will be noted that the number of parts has been reduced to the minimum; all moving parts entirely eliminated, and that there are no restricted oil passages that are not readily accessible for cleaning. It is of the class of burners commonly known as the outside-mixer type, and is exempt from the clogging, due to

carbonization and foreign substances in the oil, so common to those of the inside-mixer type. On a recent trial trip of a vessel fitted with burners of the inside-mixer type one Ingram burner was installed for comparison. While raising steam to get under way the burner was adjusted and was not altered until the vessel returned to her dock, while all the other burners were constantly being relighted from the Ingram. This vessel is now installing a complete outfit of Ingram burners. They will atomize with either steam or air, and it is claimed are highly efficient over a very wide range of pressures on both the oil and the atomizing agent. The finished burner, as put on the market, is shown in Fig. 1. It was the aim of the inventor, through several years of experimenting with fuel oils, to produce a burner of the maximum efficiency at the least cost and one which would require little attention from the operator.

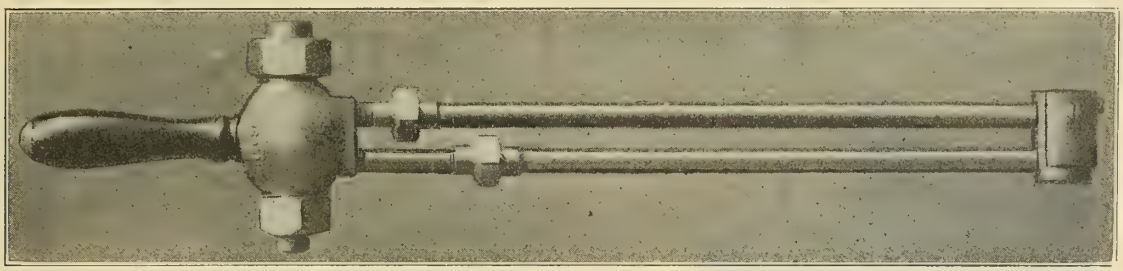


FIG. 1.

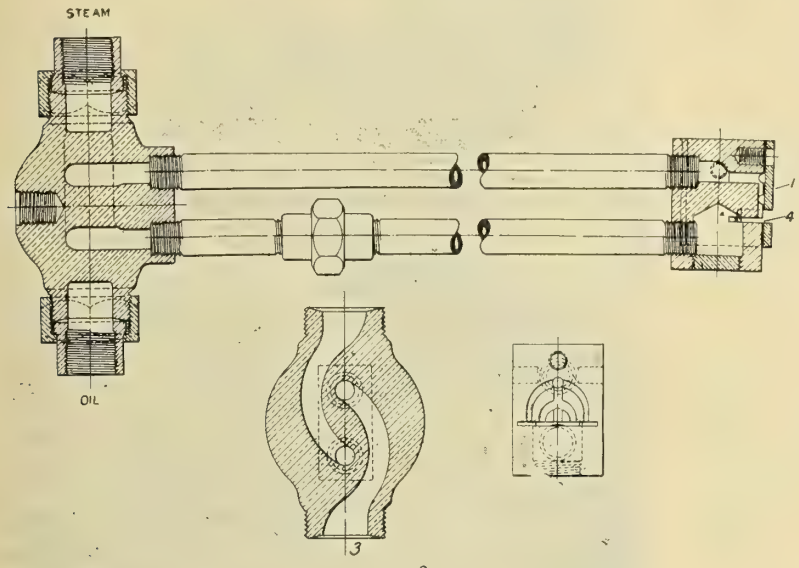


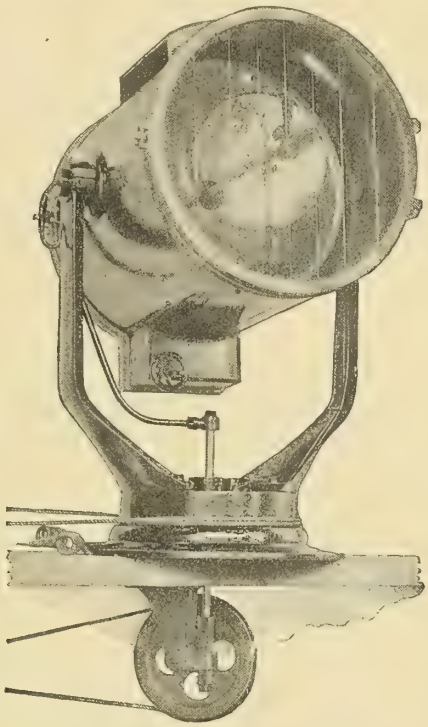
FIG. 2.

The patents for the Ingram burner are owned and controlled by the Ingram Fuel Oil Burner Company, of Newport News, Va., who are supplying the demands of the trade, and they are manufactured for them by the Newport News Shipbuilding & Dry Dock Company, whose established reputation for careful workmanship is carried out in the construction of these burners.

Carlisle & Finch Searchlights.

Searchlights are coming into such general use for steamships, yachts, and even launches that no boat is now considered complete unless equipped with one of them. They are made in a great many different sizes, from the smallest 7-inch yacht lamp to the large 60-inch naval projector, the most common sizes being 7 inches to 24 inches diameter, which are found on vessels of the United States navy, vessels of the United States Engineer Department, coasting steamers, river steamers, etc. The Carlisle & Finch Company, 234 East Clifton avenue, Cincinnati, Ohio, have long been connected with this particular industry, being among the first to recognize the value of the horizontal carbon arc.

This company has given particular attention to developing a thoroughly practical line of searchlights that will require little attention, and that will always be ready and reliable. The type shown herewith is used extensively on Western river steamers, where the light is placed at the forward end of the boat, and its motion controlled by the pilot in the pilot-house. The lamp is provided with both horizontal motion and vertical motion, each of which is controlled by separate cables.

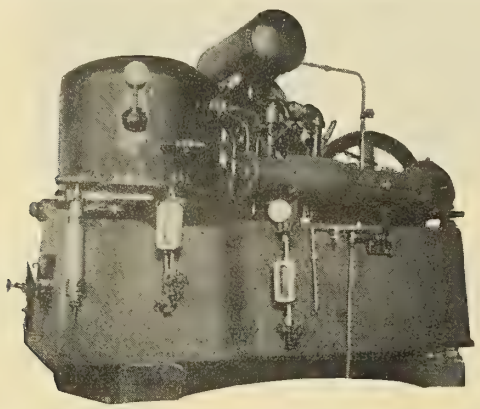


A Small Brooke Motor.

J. W. Brooke & Company, Ltd., Lowestoft, have recently brought out a small 3-horsepower two-stroke motor, running with magneto ignition, which is particularly suitable for use in small ship's dinghies and pleasure boats, where convenience is of more importance than speed. This motor is designed for reliability, and extensive preparations have been made by the manufacturers for producing them at low cost. The power developed is 3 horsepower at 900 revolutions per minute. There are many good features about the motor, chief of which is the skew-driven magneto with a single wire from the magneto machine to the sparking plug, and an automatic carburetor with only the throttle adjustment on it.

Svea Caloric Engine.

In our issue for August, 1905, we described briefly the Svea caloric engine, which is an internal-combustion engine operated by hot air. The air is heated from below, a volume of cool air being split up into thin sheets, and then passing over heated plates at a predetermined velocity absorbing the heat radiated from these plates. A 2-horsepower engine with cylinders 4.25 inches diameter and 4.875 inches stroke has recently been tested with the following results: Pressure, 40 pounds; tem-



perature, 450 degrees F.; revolutions per minute, 200; indicated horsepower, 2.4; brake horsepower, 1.7; fuel per brake horsepower, 4.9 pounds. Considering the fact that a steam engine of the same size would probably require from 10 to 15 pounds of fuel per horsepower-hour, the Svea engine shows remarkable economy. It is estimated that in a 100-horsepower engine of this type, designed for a pressure of 250 pounds at a temperature of 700 degrees F., an economy of 1 pound of fuel per horsepower-hour or less would be obtained. This engine is controlled by the Svea Caloric Engine Company, 119 Nassau street, New York.

Rope Tests.

In order to determine the amount of variation in the behavior of specimens of manila rope a large number of tests have been made recently by the Plymouth Cordage Company, of North Plymouth, Mass. Twenty-two samples of 3-inch manila, each specimen the product of a different manufacturer, were compared as to weight per unit of length and average tensile strength. The results were plotted with the Plymouth Cordage specimen used as a standard, and the percentage variations either plus or minus of the different samples figured from this standard.

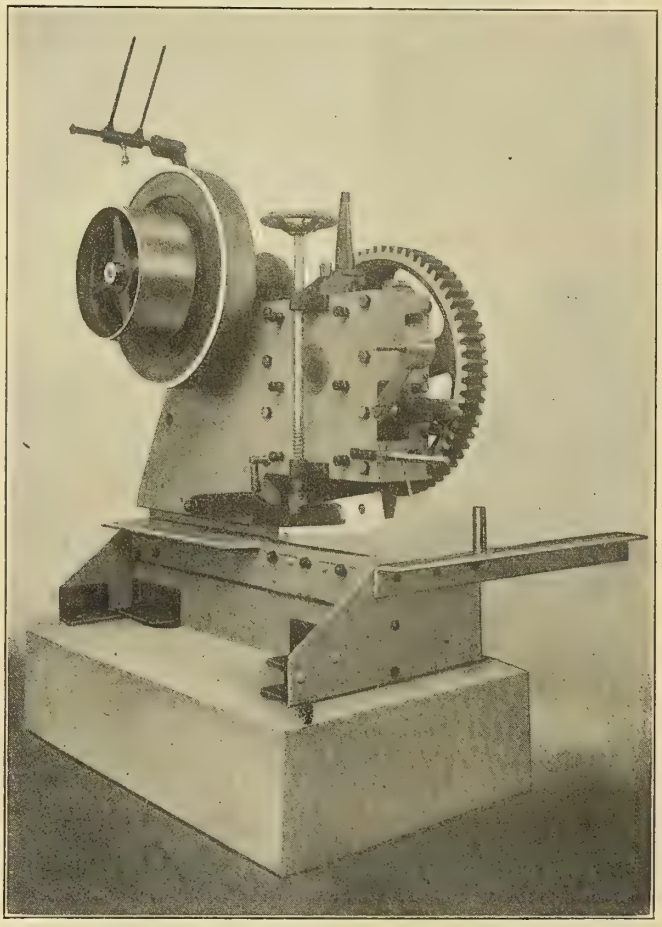
The extent of these variations is remarkable, the weights varying from minus 9.6 percent to plus 22.6 percent, with an average deviation of plus 7.85 percent, while the variations in strength were even more striking, ranging from plus 2.5 percent to a minimum of minus 43.7 percent. The average strength deviation from the Plymouth specimen was minus 14.6 percent. Not only is the extent of these deviations from a given standard surprising but also the fact that there seems to be no logical relation between the shape of the weight curve and that of the strength curve. In many cases the latter rises when the former shows a depression and vice versa.

A very evident lesson which these results points out is that there is room for considerable work in the matter of standardizing the production of rope so that size and weight will give more indication of the amount of strength to be expected from a sample. How shall anyone be able to foretell the load that may safely be carried by a 3-inch manila rope when the specimens tested in this series showed results varying all the way from 9,010 pounds for the maximum to 4,946 for a minimum, with the remaining samples scattered promiscuously over the area between? If rope is purchased with its strength based upon the minimum, which would naturally be a safe method, it is likely to have a maximum strength, in which case it could well be of smaller size, while if the average value was taken it may possibly be considerably weaker than has been figured upon, with a consequent shorter life.

It certainly seems that the standardization of rope making should be made the object of rope makers everywhere, and the work of the Plymouth Cordage Company in this series of tests is an important step in the right direction.

A New Pels Splitting Shear.

Henry Pels & Company, 90 West street, New York, exhibited at the recent Brussels Exposition a splitting shear which has added features of interest, among them being knives of extra length, a patented stripper with a very large bearing surface, and an adjustable gage and guiding pin. These aid materially in reducing the difficulties met with in dealing with



heavy plates of large dimensions, and greatly increase the speed of cutting.

The construction of the product of this concern is well known to the trade. The frame is built of one, very heavy, rolled, open-hearth steel plate, reaching in the largest machines a thickness of 6 inches. The tangent and straight channels are milled out of the frame, and the fact that these channels are smooth and without fillets, it is claimed, makes the passing of the plates through the shear an easy proposition.

The tool is built in eight sizes, the smallest dealing with steel up to ⅜ inch, and the largest taking care of plates 1½ inches in thickness. The illustration shows a machine of medium size, which is capable of cutting plates up to ¾ inch in thickness and of unlimited length and width. The knife is 20 inches long, and it is claimed will shear at a single stroke a ½-inch plate 18 inches wide. The frame is 5¼ inches thick, and is guaranteed to stand up under the severe strains of cutting at the highest capacity continually with ease. Only 6 horsepower is required to drive the machine, and it weighs approximately 6,000 pounds.

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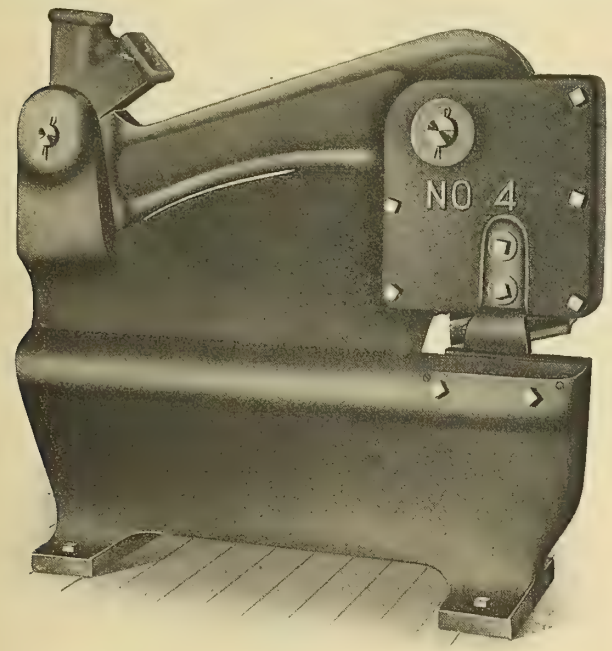
Beloit Lever Splitting Shears.

Slater, Marsden & Whittemore Company, Beloit, Wis., have on the market a line of splitting shears designed for cutting plates from ¼ inch to ½ inch thick by hand. The shears are operated by a lever, but the lever works from the back of the machine, so that the operator is out of the way when cutting large sheets. The bodies are offset so that when splitting



large sheets the metal will pass through freely. The knives are adjustable and reversible, giving four cutting edges. They are also easily removed for sharpening. In the machines designed for cutting ¼-inch and ⅜-inch plate the knives are 6½ inches long, and for cutting ½-inch plate the knives are 7 inches long.

COMMUNICATION.

Simpson's Rule for Beam of a Vessel.

Editor International Marine Engineering:

Referring to the letter by "H" in your January issue, in which your correspondent directs attention to formula 14 on page 45 of "Simpson's Naval Constructor" (D. Van Nostrand Company), I beg leave to state that in the first edition of this book the large vincula embracing the two first terms was omitted in printing, but was corrected in the second edition, which gives the formula:

$$B = \sqrt{\left[M - d\left(\frac{5\alpha - 2\delta}{6\alpha}\right)\right] \times \frac{d}{m}}$$

Had your correspondent traced the genesis of this formula by referring to Nos. 7 and 17 on the same page, and compared these with pp. 12-15, he would readily have noticed the omission referred to. The formula is a combination of Normand's approximate formula for the height of center of buoyancy, and the approximate formula for *B. M.* expressed so as to give the required breadth of waterline corresponding to a given metacentric height. G. Simpson.

New York.

TECHNICAL PUBLICATIONS.

The Mechanical World Electrical Pocketbook for 1911. Size, 4 by 6 inches. Pages, 270. Figures, 68. London, 1910: Emmott & Company, Ltd., 20 Bedford street, W. C. Price, 6d. net.

This book is a companion volume to the "Mechanical World Pocket Diary and Year Book" which is reviewed in this issue. As has been the custom in previous years, the book has been thoroughly revised and brought up to date by the addition of new material. Among the important additions to the book this year are tables of current densities; permissible temperature rise; percentage losses in electrical machinery; units of illumination; current consumed by incandescent lamps; life of glow lamps; depreciation allowance; etc. Some of the sections which are briefly treated in this book are considered more fully in the Pocket Diary and Year Book and readers are referred to that volume for information on such subjects.

Nautical Technical Dictionary for the Navy. English, French, German and Italian. Volume II.; Part II. Size, 6¼ by 9¼ inches. Pages, 1,115. Pola, Italy, 1910: Mitteilungen aus dem Gebiete des Seewesens. Price, 20/10.

This is the second volume of a dictionary which gives in detail, in four languages, all technical expressions relating to nautical maritime science, and information connected therewith. It includes that part of the alphabet from L to Z. The dictionary is arranged in two ways; first, alphabetically with English and French words in sequence; and second, systematically, according to the similarity of the technical application of the words. The authors have used the greatest care to search out the correct technical meaning of every nautical and technical expression, so that the book may be valuable for reference to magistrates when trying maritime cases where seamen of all nations have to be dealt with. The value and usefulness of the book is apparent and its accuracy can be vouched for by the large number of distinguished collaborators who assisted in the preparation of the volume.

The Indicator Handbook. Part I. Fourth Edition. By C. N. Pickworth. Size, 5 by 7¼ inches. Pages, 142. Figures, 93. New York, 1910: D. Van Nostrand Company, Price, $1.50.

Little needs to be said regarding a book which has been before the public for such a long time, and which has been so favorably received by practical engineers. The present edition, however, has been enlarged and extensive revisions have been made where necessary. Recent improvements in the manufacture of various types of indicators have necessitated changing that part of the book devoted to the description of different instruments. A new chapter has been added which is devoted exclusively to a consideration of the indicator for oil engines; also descriptions and illustrations of reducing gears for gas engines are included, while optical indicators, pressure indicators, etc., are also considered. This work has long been recognized as a very complete and practical treatise on the steam-engine indicator, and we are pleased to find that the additions are fully as comprehensive and accurate as the original matter.

The Mechanical World Pocket Diary and Year Book for 1911. Size, 4 by 6 inches. Pages, 422. Figures, 94. London, 1910: Emmott & Company, Ltd., 20 Bedford street, W. C. Price, 6d. net.

This is the twenty-fourth year of publication of this pocket book and each year the contents are enlarged and brought up to date. Some thirty-two pages have been added to the present volume and, by careful revision and condensation of some of the more permanent contents, space has been afford-

ed for the introduction of a very large amount of new matter. Particular attention is directed by the publishers to an important chapter on the shapes, speeds and feeds of cutting tools, with supplementary sections dealing with milling cutters and twist drills. Additions have been made to the section on wheel gearing and entirely new sections on standard screw threads, high-speed steel and its treatment, annealing, hardening and tempering, and the constructive details of gas engines, have been added. There are also new tables and data on marine boilers, riveted joints, etc., and a table of steam fittings has been included, together with several additions to the tables of weights and measures. Taken all in all, this book provides a convenient and valuable reference book for marine engineers.

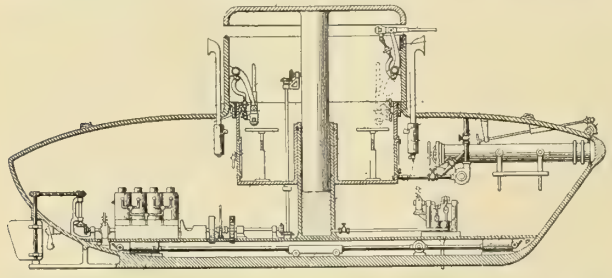
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

971,676. SEMI-SUBMERGED SUBMARINE GUNBOAT AND TORPEDO BOAT. HARRY HERTZBERG, OF BROOKLYN; ABBOT A. LOW, OF HORSESHOE, AND MAURICE J. WOHL, OF NEW YORK, N. Y., ASSIGNORS TO ABBOT A. LOW, OF HORSESHOE, N. Y.; HARRY HERTZBERG, OF BROOKLYN, N. Y., AND MAURICE J. WOHL, OF NEW YORK, N. Y., TRUSTEES.

Claim 1.—A submarine vessel, having a conning tower projecting upward therefrom, and a bucket-shaped bottom secured at the base of the conning tower within and walling off the interior of the tower from the



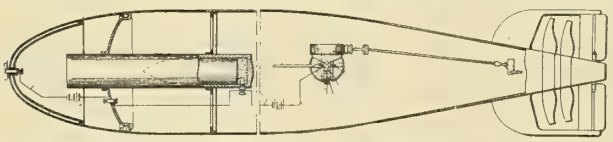
remainder of the interior of the vessel, said bucket-shaped bottom being depressible so as to afford free access to the interior of the conning tower. Six claims.

971,699. REACTION PROPELLING MECHANISM. WILLIAM SOLOMON, OF CHEYENNE, WYOMING.

Claim.—In a propelling device for vessels, an air reservoir, a plurality of reaction tubes, separate ducts leading from said reservoir each connected to one of said tubes, valves in said ducts having their ports disposed at angles to each other, a common stem whereon all of said valves are mounted whereby the ducts will have the respective valves open and closed in succession, a prime motor, an air compressor actuated by the prime motor, and an operative connection between the prime motor and valve stem to rotate said stem as the engine operates. One claim.

972,064. GYROSCOPICALLY-CONTROLLED TORPEDO-FIRING APPARATUS. CLELAND DAVIS, OF THE UNITED STATES NAVY.

Claim 1.—The combination with a torpedo carrying an explosive charge, of a gyroscope mounted in said torpedo, and means actuated by



said gyroscope for firing said charge when the torpedo is deflected through a predetermined angle from its original course. Four claims.

973,772. VESSEL-LOADING ALARM. JAMES GEDEON, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-THIRD TO CHARLES L. BROWN AND ONE-THIRD TO ROBERT D. MANSFIELD, BOTH OF CLEVELAND, OHIO.

Claim 1.—In a vessel loading alarm, the combination of a stand-pipe located within the hull of the vessel and communicating with the water outside of the hull, a vertical tube therein open at the bottom, a windlass for adjusting said tube with relation to the draft of the vessel, electrical terminals within said tube, an arm pivotally connected to one of said terminals; a float suspended from said arm, and adapted to raise the arm into contact with the other terminal when the water level reaches a predetermined height with relation to the vessel. Two claims.

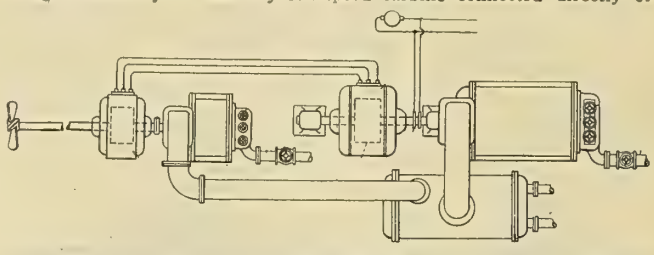
973,774. MEANS FOR INCREASING TENSION OF GASEOUS PROPELLANTS FOR TORPEDOES. MAX GLASS, OF VIENNA, AUSTRIA-HUNGARY.

Claim 1.—In a torpedo, means for increasing the tension of a gaseous driving fluid, comprising a coil through which said driving fluid passes, an acetylene burner arranged axially within said coil for heating the same, an acetylene generator mounted on the inner face of a wall of the torpedo and means for feeding said burner therefrom. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

26,346. PROPULSION OF SHIPS. THE BRITISH THOMSON-HOUSTON COMPANY, LTD., LONDON.

By this invention the propeller is driven in a forward direction by means of an electric motor supplied with current from a generator driven by a relatively high-speed turbine, the driving in the reverse direction being effected by a relatively low-speed turbine connected directly or



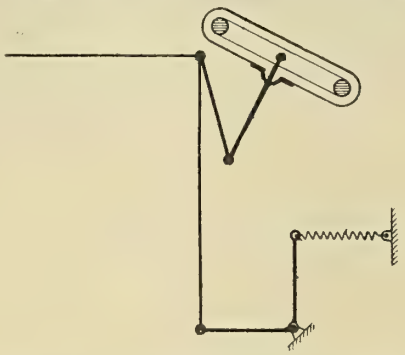
through gearing to the propeller shaft. By using a separate turbine solely for reversing purposes the turbine-driven generator and motor are always kept in the proper phase relation, and powerful and effective agencies are always available for propelling the ship in either direction.

26,812. HOPPERS FOR LOADING STEAMERS. W. H. BAUMANN, NEWCASTLE-ON-TYNE.

The objects of this invention are to prevent breakage of the coal being fed down the chute and to save time and labor during trimming. To this end, the hopper is made in sections connected telescopically. The lowermost section has connected to it two chains which pass through eyes upon the intermediate sections, the upper ends of the chains passing around drums rotatably mounted in the mouth of the hopper. Means are provided for rotating the shaft so as to wind in the chains and raise first the lowermost and then the intermediate sections as required by the progress of bunkering.

27,687. MAINTENANCE OF THE EQUILIBRIUM OF VESSELS, ETC., BY GYROSCOPIC ACTION. R. SCHERL, DRESDEN, GERMANY.

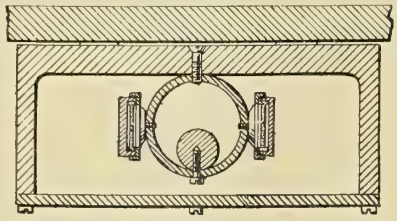
Patent No. 21,843-1909, to this inventor, describes the application of means for accelerating the speed of precession of a gyroscope in order to diminish the oscillation of the carriage, and in patent of addition, No. 27,590-1909, the additional forces acting on the gyroscope are made dependent in value on the speed of precession. In the present invention



the servo-motor acts on the gyroscope frame through an elastic medium 12, under the influence of which the point 6 is moved upward, and which exerts a moment on the gyroscope that, when the lever lengths 3 and 4 are equal and the oscillations about point 13 small varies nearly with the distance apart of points 14 and 6. The latter, however, is influenced by the to-and-fro action of the servo-motor whereby the moment exerted by spring 12 is varied so that the additional moment acting on the gyroscope is controlled by the servo-motor.

25,191. SUBMARINE SOUND SIGNALING. J. GARDNER, FLEETWOOD.

By this invention the ship's sides are employed as diaphragms to collect vibrations for transmission to a receiver or signaling device. In order to avoid any other than lateral vibrations the microphones are mounted on an inertia ring weighted at its free side, or it may be cut



there. A resistance may also be included in the circuit to damp longitudinal vibrations. A device at each side of the ship is connected by a switch with a telephone circuit, or, with a relay for visual signaling, so that the microphone transmitting the stronger vibrations may be used.

7889. PROPELLER. F. BROUSSOUSE, LIEGE, BELGIUM.

Each main blade of the propeller is provided with one or a series of auxiliary directing blades, each series comprising one or more elements fixed on the boss, *en echelon* on the same side as the acting face of the main blade, and their pitch is less than that of the main blade, decreasing from one directing blade to the other. With this propeller a progressive deviation of the section of fluid is secured, the eddies and dead water produced by ordinary screw propellers being avoided.